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editor's letter

ISSUE 27

I t's easy to become overwhelmed by the exponentially-growing evidence of climate change. Many of us cope with this existential dread and the attendant feelings of helplessness in light of a problem that may seem too vast, nebulous and intractable to tackle by detaching ourselves from it, ignoring our personal responsibility. After all, what difference can the actions of one person make in a planet of seven billion and counting? But radical action is called for on both a personal and societal scale.

And the notion that climate change is intractable, aside from being defeatist, is incorrect and too simplistic. The very real risk of runaway climate change notwithstanding, we mustn't think of climate change as a fight that we either win or lose. The issue is far more nuanced. The real question we need to ask is to what extent the climate will change, what we can do to limit this insofar as possible, and what we need to do to prepare ourselves – on a whole civilization level, right down to how and where we build and fix up our homes. And don't be confused by our focus on buildings in this magazine. We are aware, of course, that the actions we must take regarding our new and existing building stock are only a fraction of the answer.

The paradox we face in Ireland and the UK is that while global temperatures will continue to rise, there's increasing evidence that changes to microclimate may mean that we see extreme and prolonged weather events at both ends of the scale: heatwaves that may make Summer 2018 look like a walk in the park, and cold snaps to match – with a dollop of increasing wind-driven rain and whatever you're having yourself.

This poses some extremely tough questions in terms of how we plan settlements, how we shore up our existing communities, and how building designs should respond. Our assumptions about flood risk may go out the window. We'll need to think much harder about how we protect our building fabric from the elements. And we'll need to balance the risk of making buildings dangerously hot during heatwaves, and too hard to heat in cold snaps. We need to prepare for all of this while emitting the least amount of carbon in the first place.

How we address climate change may rank as humanity's greatest challenge. None of us should lose sight of the roles we have to play, however seemingly small. And for those of us for whom self-interest motivates us more than the impact we have on our children's generation or on people in vulnerable regions around the world, a wake-up call: anyone planning on living in a building in the coming decades has a personal interest in the threats that an increasingly volatile climate pose. It's personal.

Regards,
The editor

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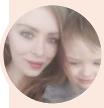
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The Deerings, by Gresford Architects
Photo: Quintin Lake

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Once poorly understood by the mainstream building industry, airtightness is now increasingly seen as one of the most crucial objectives on any building project. Not only is it vital for energy efficiency, it's also key for thermal comfort and for protecting a building's structure from dampness and mould. In this comprehensive guide to airtightness, we look at why it's so important, how exactly it's measured, and most importantly, how to achieve it on site.

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Are you deep green or pale green?

The human mind is skilled at finding ways to dissociate itself from the need to act on climate change, writes Dr Peter Rickaby.

I have spent most of my career translating. My aim has been to translate the experience, ideas and wisdom of the people I think of as the 'deep greens' of building and housing into guidance, training and standards that can be adopted by mainstream industry. It is a frustrating task, because the greens' message is not always clear, and the audience is often reluctant.

Deep greens are people for whom I have respect, because they are showing us the way to the sustainable buildings and housing of the future. They are the passive house certified designers, members of the Passivhaus Trust, the Good Homes Alliance, the AECB, the STBA and the ASBP. They include many academics, notably associated with UCL's Energy Institute, the Oxford Environmental Change Institute, Oxford Brookes University, Dublin Institute of Technology and several other institutions.

There are plenty of deep greens scattered around in consultancies and housing organisations, where their skills are mostly under-appreciated. These people don't just talk the talk, they walk the walk: they live in passive houses or deep retrofits, they ride folding bicycles, use public transport or drive EVs, and try not to fly. One of them told me the only hot water he uses each day goes into his nightly hot water bottle (his house is cool) – in the morning he pours it into the washbasin and shaves with it!

I divide the audience for my translations into two. The more interesting group I call the pale greens. These are productive people who acknowledge the challenge of climate change, and the need for our professional and personal behaviours to respond, but who carry on regardless. They are open to incremental change, but they don't challenge standards, or their clients, or the outcomes of their projects. At work, pale greens produce buildings that are claimed to be sustainable but are in practice just a little less unsustainable than all the others. Pale greens talk the talk, but don't walk the walk. Why not? They are people we should be able to influence.

My wife is studying psychology, and one of her books has a chapter on the psychology of environmentalism. It's an interesting read that explains why pale greens behave as they do. The term 'cognitive dissonance' describes the clash in our heads between our understanding of the implications of climate change and the norms of behaviour that we have assimilated throughout our lives, with which we are familiar and secure. It's that uncomfortable feeling that we might be wrong.

There are other psychological mechanisms. One is the excuse that it is pointless to change our behaviour because the Chinese are opening new coal-fired power stations and the Brazilians are cutting down rainforest. Another is the view that the challenge of climate change is not for us but for 'them', i.e. industry, or government, or the EU – someone else.

Finally, climate change is over the horizon – we don't have to think about it now. It seems we are better adapted by evolution to solving immediate problems than anticipated ones. (This explains a lot of history, as well as the expression "I told you so!")

I call the other audience group the blues, because they are so depressing. They are not climate change deniers, but they don't care about it. They care about the bottom line (making money), their career progression and success, and maintaining their standard of living at everyone else's expense. The blues are dinosaurs: they won't evolve, and they are due to go extinct. I prefer not to waste time on them — the psychologists don't seem to have much to say about them either.

Finally, what about me? To be honest, I'm pale green. I live and work in a well-insulated, mid-floor flat with a condensing boiler. I travel mostly by bus and by train, but we own a car and clocked up 9,000 miles last year. Our weekends away are always in the UK, but we flew to South Africa this year to visit my wife's family, celebrate her mother's 86th birthday, and meet our new grand-daughter. I don't feel guilty about that trip, but I do about the 16,000 miles of flying.

I'm also working with my son (who is a doctor) on a scheme that facilitates UK doctors volunteering in Malawi, the poorest country in Africa, where their skills are desperately needed. If the scheme succeeds we will be flying eighteen doctors to Malawi and back each year. I don't feel guilty about that either, but it shows how difficult it is to convert pale green to deep green. In mitigation, I'm writing a UK domestic retrofit standard and a retrofit training course (both more translating) that I'm hoping might eventually pay off some of the carbon debt. ■

> “The term 'cognitive dissonance' describes the clash in our heads between our understanding of the implications of climate change and the norms of behaviour that we have assimilated.

Peter Rickaby is a Trustee of the National Energy Foundation, a member of the Each Home Counts Implementation Board, chairs the BSI Retrofit Standards Task Group and is the training lead for the UK Centre for Moisture in Buildings at UCL. The opinions expressed here are his own.

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INTERNATIONAL

A SELECTION OF PASSIVE & ECO BUILDS FROM AROUND THE WORLD

Photos: John Muggenborg
Drawings: Baxt Ingui Architects

CARROLL GARDENS TOWNHOUSE, BROOKLYN, NEW YORK

Achieving Enerphit, the Passive House Institute's retrofit standard, is tough enough. But this five-storey brownstone in Brooklyn went much further: not only did it achieve the full passive house standard, more commonly targeted by new builds, it also became the first 'passive house plus' project in the US. This benchmark is awarded to projects that produce, on site, about as much electricity in the form of renewables as they consume from the grid.

Designed by Michael Ingui, Will Conner and Frankie Failla of Manhattan-based Baxt Ingui Architects, veterans of turning old NY brownstones into passive houses, the project was finished in 2014 and certified two years later. The team also included contractor PJoe Construction and passive house consultant sgBuild.

The extensive retrofit doubled the floor area of this luxury terraced home to 412 square metres with the addition of a three-storey extension to the rear, and a new level on top that features large sliding doors, a roof deck and whopping 36 square metre solar PV array.

To insulate the old facades and make them airtight, the team built a new timber frame against the interior of the exposed walls, insulating the new studwork with densely-paced cellulose, and making them airtight with taped high-grade plywood.

"Through our consultant's research and modelling we found that plywood acts in much the same way as a smart membrane when it comes to moisture, as long as it is higher grade ply," says project architect Will Conner. "One advantage of the plywood for us was that every carpenter on site was familiar with it and felt comfortable manipulating the material. At the time of this project, smart membranes were all very new to our team. Plus, it was much more difficult to accidentally puncture the plywood."

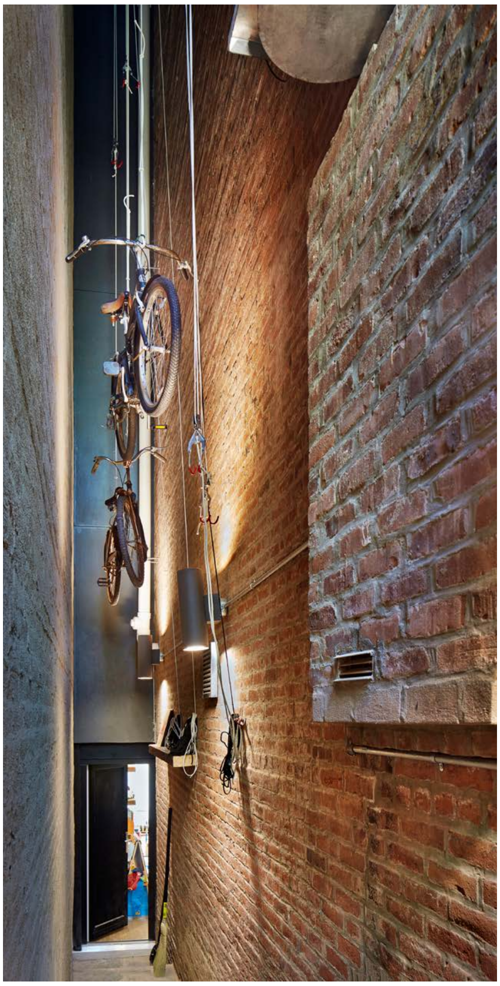
This strategy was also carried over to the new extension: built from masonry, it was then fitted out with an airtight, insulated timber frame internally. The original party walls, meanwhile, were made airtight with a liquid membrane and insulated with mineral wool.

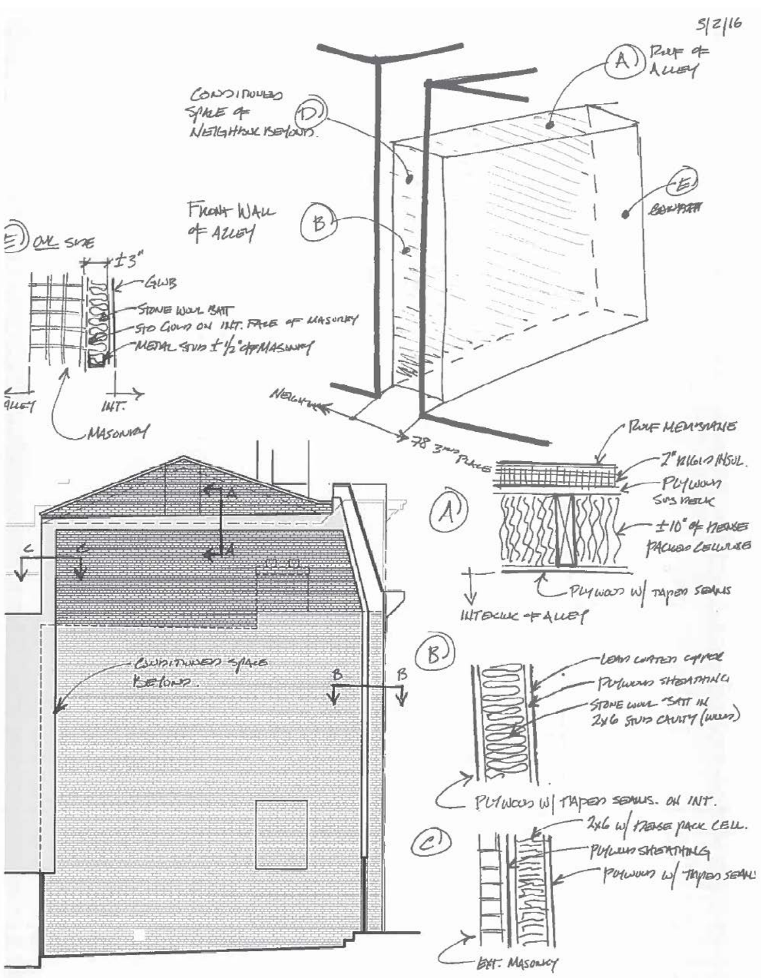
Perhaps the most intriguing design challenge for the architects was a narrow, three-foot-wide alleyway to the side of the house. While the alley originally stretched right through to the back yard, the new extension cut across it at the rear, so the laneway now terminated with a door leading into the new part of the house.

This created a semi-enclosed courtyard, but it would not comply with city building rules that say such spaces must be sufficiently deep to ensure good quality natural light and ventilation for any rooms that open onto them.

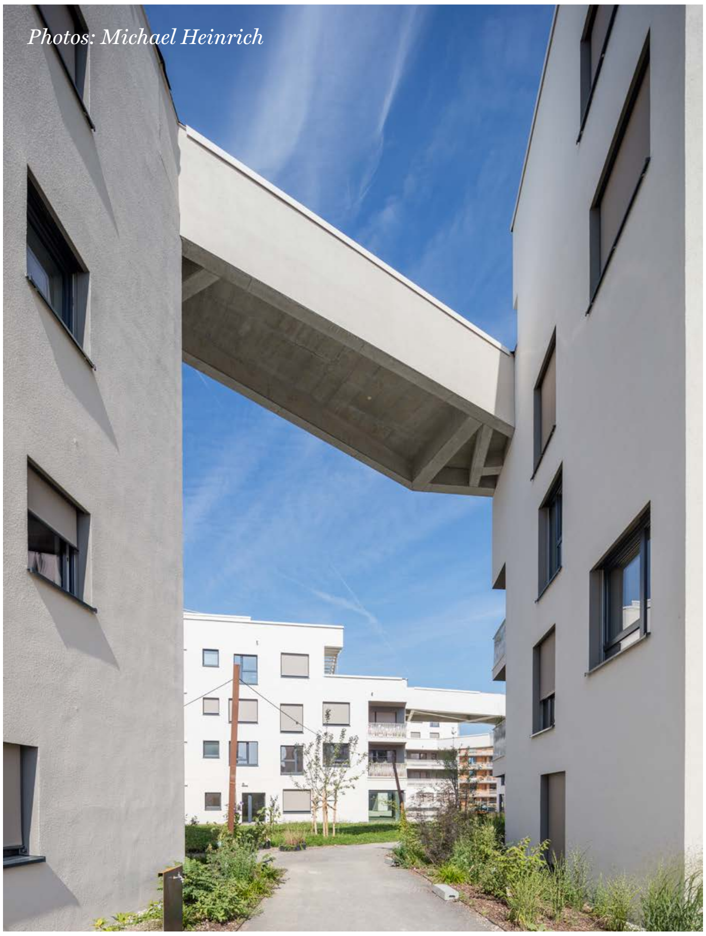
Baxt Ingui's solution? Bring this narrow alleyway into the envelope of the house by building a timber-framed roof and front wall on the alley, fully enclosing it. This made it easier to the reach the passive house standard, too, because it meant the house had one less fully exposed wall.

"Architecturally, this created a really interesting and unique space, being about three feet wide, 30 feet long and 30 feet tall," says Conner. The homeowners currently use the space to store bikes but are considering putting a climbing wall here. ▶

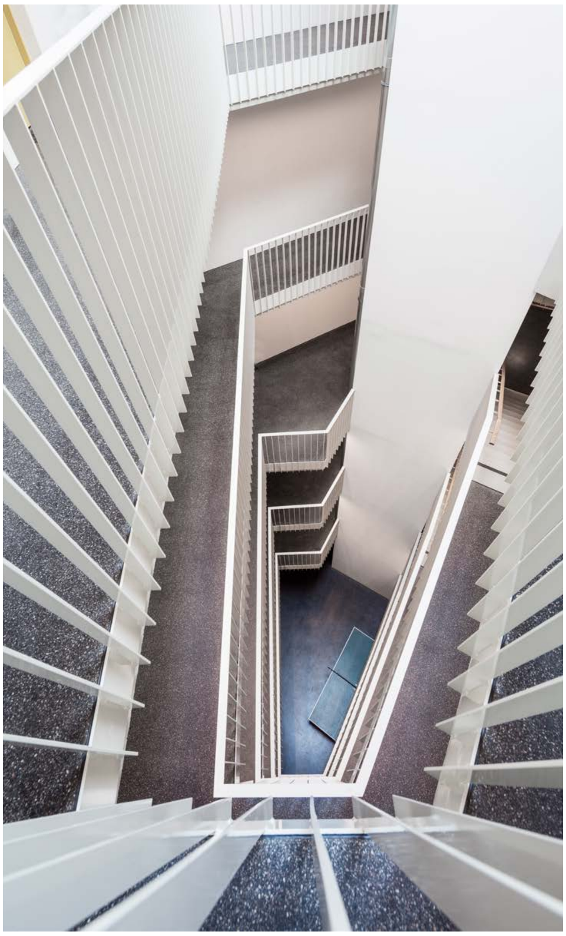




(top left) the wine room and **(top right)** the roof deck with rooftop solar array; **(above)** city building rules meant the team had to fully enclose a narrow three-foot-wide alley running down the side of the building. The space is now insulated and even has its own ventilation system, and is currently used for storing bicycles.



Photos: Michael Heinrich



WAGNISART, MUNICH, GERMANY

Is this the future of sustainable urban housing? The WagnisART development is a passive house certified scheme of 138 apartments in Munich's Domagkpark residential district, the site of a former barracks that has now been redeveloped into a community of 4,500 people.

The area was also previously home to a large artist's colony, which has now been incorporated into the WagnisART development, and gives the project its name.

Designed collaboratively by two architecture firms, Bogevischs Buero and Schindler Hable, the finished project features a mix of social housing, subsidised market housing and standard private homes.

These are spread across five apartment buildings, which are organised around large central staircases. The layout of WagnisART is designed to create courtyards and passages that open the complex up to its surroundings, while also forming intimate communal spaces for inhabitants (the residents themselves voted on this design over the alternative option of one large building with a central internal courtyard).

The buildings are constructed from timber frame panels that hang off a steel and concrete skeleton. Heat, meanwhile, is supplied by the local district heating network, while the roofs feature a combined total of 94kWp solar photovoltaic power. Electricity produced from this system is fed into the local grid.

On the top floors, the buildings are connected to each other via walkable bridges, which also create a "roof garden landscape" and a second, semi-public community space. On the ground floors, meanwhile, the buildings feature common rooms, workshops, studios and commercial business spaces so residents can live and work in close proximity.

NEWS

New UK retrofit standard will mandate ventilation & post occupancy checks

PAS 2035 follows high profile retrofit failures under government schemes

Words: Kate de Selincourt

Big changes to the way government-backed retrofit is carried out in the UK — including requirements to install ventilation, and to assess every retrofit measure after installation – are being proposed under PAS 2035, a new specification for the energy retrofit of domestic buildings.

PAS 2035 has been developed as part of the 'Each Home Counts' process, which was established to tackle the high level of failure in domestic retrofit under government-backed schemes, such as that at Preston (pictured, and profiled in the UK edition of issue 24 of Passive House Plus). Passive House Plus columnist Peter Rickaby is chair of the BSI Retrofit Standards Taskgroup - the overarching group behind the development of the standard - and technical author of PAS2035, working with an industry steering group.

The UK government has also said that it intends to adopt a proposed new quality mark for installers, along with mandating the PAS standard for all government-backed energy efficiency schemes, possibly as soon as next spring – although it has also promised a "sufficient" transition period.

There is also commercial pressure on the retrofit industry for the adoption of these standards. A number of lenders are reportedly keen to lend into the able-to-pay home retrofit market, but say they want the work to be subject to these new standards in order to "de-risk" the loans.

In the meantime, clients who fund retrofit work, for example to address fuel poverty, are looking to use the scheme to help with procurement. As Rob Hargreaves, who runs fuel poverty programmes at Severn Wye Energy Agency told a recent Gloucestershire event on health and housing: "We are working with vulnerable people. A scheme which reassures us about the quality of the contractors and their work is really welcome."

Among the provisions in the draft version of PAS 2035 are:

- Designated roles: project designer, project manager, retrofit co-ordinator, retrofit assessor, with minimum qualifications and/or professional accreditations for each
- The option to carry out performance modelling with PHPP, the passive house design and assessment software, as an alternative to SAP
- A requirement to check ventilation in all retrofit properties, and to upgrade the system when it fails to meet set criteria
- Compulsory post-installation assessment via occupant and client questionnaires.

Under Each Home Counts, all installers carrying out work as part of government schemes will also be required to be registered with a body (for example a trade organisation) that is licenced to deliver the new quality mark, which is due to be launched by the traders' scheme TrustMark this October. Participating bodies will have to audit all members regularly, and also enforce a code of conduct and customer charter.

To be compliant with PAS 2035, retrofits will also need to have designs carried out by a nominated professional – depending on the project complexity, this could be an architectural technologist, architect or chartered surveyor.

All retrofits must have an identified and appropriately trained project manager, and retrofits falling into a 'high risk' category must be overseen by a qualified retrofit co-ordinator.

Under the proposed standard, ventilation in any dwelling where energy retrofit is to take place has to be assessed. If there is evidence that ventilation is inadequate, such as mould or missing trickle vents, and the building fabric is to be upgraded, then working ventilation must also be installed. Even if the building fabric is not being altered, the building owners will have to be formally notified of the finding.

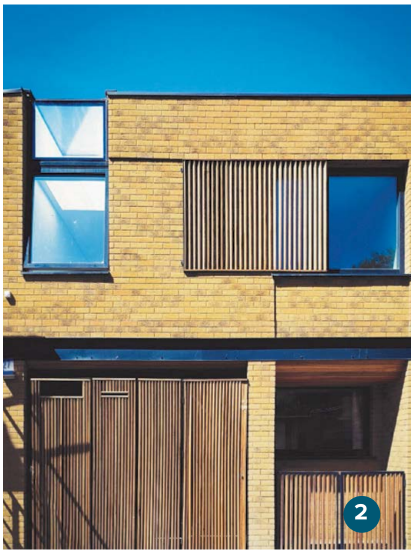
Proposed standard states that the capacity of installed ventilation systems will have to allow for the largest potential occupancy of the dwelling (two adults in each bedroom). If the intention is to upgrade the building envelope to an airtightness of tighter than 5 m^3/m^2h (Q50), then demand controlled mechanical extract ventilation (dcMEV) or mechanical ventilation with heat recovery (MVHR) will have to be installed, according to a strict set of criteria – including commissioning for noise.

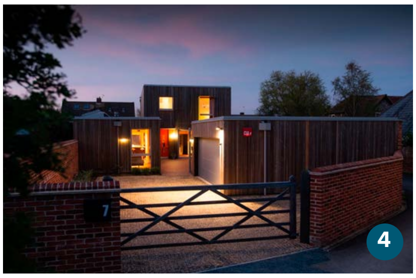
Under both the proposed PAS 2035 and the new provisions for the quality mark, installers will be responsible for seeking and recording feedback on all installations after completion. Occupants and clients will be asked if the retrofit has met the intended outcomes of the project (as agreed between the project manager and client at the start), and whether they are satisfied. If there is cause for concern, recommendations for action will be made, and if the issue is not resolved, the assessment process can be escalated to include further investigations and interventions.

"This is about learning," said Kerry Mashford, the verification and monitoring lead for Each Home Counts. "Very often when outcomes are not what was expected, we don't know why, and now we have an opportunity to investigate systematically. We will be learning not only from customers but also hopefully from metered performance, and will work to understand what is going on. And this will be fed back to everyone in industry." ■

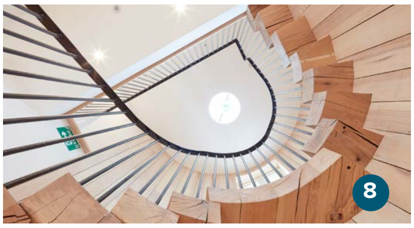
(above) How not to do it: work like this disastrously poorly detailed external insulation in Preston laid bare the need for a robust retrofit standard for the UK.

UK Passivhaus Awards to be presented at London Build





The annual UK Passivhaus Awards take place this year on 24 October at the London Build trade fair. This year, nine projects have been nominated for the awards, which seek to reward passivecertified projects that exhibit a mix of robust building performance and great design. In the large residential category, sponsored by Munster Joinery, the nominees are St John's Almshouses, a sheltered housing scheme for older persons in Litchfield by KKE Architects, and Carrowbreck Meadow, an ecologically sensitive development of affordable and private homes outside Norwich by Hamson Barron Smith. In the non domestic category, sponsored by Ashden, the nominees are: the Enterprise Centre at the University of East Anglia by Architype, widely regarded as one of the most sustainable buildings in the UK; Associated Architects' George Davies Centre for Medical Studies at the University of Leicester, the UK's largest passive house certified building to date, and the Barrel Store, Cirencester, an old brewery building that has been retrofitted into an Enerphit certified youth hostel by Potter and Holmes and Greengauge Building Energy Consultants. In the small projects category, the nominees are the Hampshire passive house in Ermsworth by Ruth Butler Architects, Hope View in Cradley by Warren Benbow Architects, Old Holloway Cottage in Hertfordshire by Juraj Mikurcik (and profiled in this issue of Passive House Plus) and Passive House Mews II, a tight landfill project in London by RDA Architects. "This year we saw a range of projects that are breaking passive house stereotypes whilst striving to capture the elusive balance between architectural delight and robust building performance," said Yogini Patel of the Passivhaus Trust. For more information on the awards see www.passivhaustrust.org. ■



In addition the Old Holloway passive house published in this issue (pp24-35), the shortlisted projects include **1** St John's Almshouses; **2** Passive Mews II; **3** the Enterprise Centre at the University of East Anglia; **4** Hampshire passive house; **5** Carrowbreck Meadow; **6** Hope View; **7** George Davies Centre for Medical Studies at the University of Leicester; & **8** the Barrel Store.

Local authorities can set energy standards higher than Part L

Photo credit: Sabrina Manfield

The government has confirmed that local authorities can set energy standards higher than Part L of the building regulations, following a campaign by the UK Green Building Council (UKGBC) and others. The announcement was made in July as part of the government's response to the consultation for its new National Planning Policy Framework (NPPF).

"A number of local authority respondents stated the view that the text in the revised framework restricted their ability to require energy efficiency standards above building regulations," the government response read. "To clarify, the framework does not prevent local authorities from using their existing powers under the Planning and Energy Act 2008 or other legislation where applicable to set higher ambition. In particular, local authorities are not restricted in their ability to require energy efficiency standards above building regulations." The government also said it was committed to halving the energy usage of new buildings by 2030.

The need for clarity on the issue of local energy efficiency standards was the subject of a recent joint letter from UKGBC, Core Cities UK and UK 100, a network of local government leaders, to the former housing minister Dominic Raab.

"Having strongly advocated freedom for cities and local authorities to take a leadership role, UKGBC is delighted that government has issued a decisive position, providing clarity for local authorities and giving the green light to go further than national minimum requirements," said UKGBC director of policy and places John Alker, in response to the news.

In March this year the UKGBC, in association with Core Cities UK, published a 'policy playbook' designed to help local authorities drive up the sustainability of new homes. The guide focuses on energy and carbon, mitigating overheating risk and assuring performance. It now been updated to reflect the changes to the new NPPF and is available to download for free from **www.ukgbc.org**. ■

(above) Ambitious UK local authorities could soon follow the example of Dún Laoghaire, Ireland, which requires that all new homes meet its 'passive house or equivalent' standard under local planning rules.

Residents move into Shropshire passive house scheme

A £2m passive house residential scheme has now been handed over to residents in Shropshire. The mix of one, two and three-bedroom homes in Callaughtons Ash, Much Wenlock, comprises ten homes for social rental and two in shared ownership.

The development is intended as an "exemplar model for unlocking small green land sites and improving the quality of family living in rural areas of the West Midlands," according to architects Architype.

Known as one of the UK's leading passive house design firms, Architype also say that the project involved "re-thinking how people use domestic space in modern day families" and the way standard homes are organised.

Investigating the local vernaculars of Shropshire, the development aims to sit comfortably in its rural surroundings, complimented by a natural palette of UK sourced materials. This includes clay roof tiles that have been quarried and made within 25 miles of the site, lime render provided by local company Lime Green and UK grown thermally modified hardwood cladding.

Project architect Paul Neep said: "It has been a great experience working with South Shropshire Housing Association and the local delivery team SJ Roberts on their first passive house project. They truly embraced the standard and have proven that passive house is easily achievable when you collaborate. We are delighted at the reaction of the tenants and look forward to seeing how well the homes are performing through occupation." ■

New research finds air pollution particles in human placentas

(above) Visible pollution in the London skyline, where air pollution particles where found in the placentas of the five pregnant women tested in the Queen Mary University study.

Evidence of tiny particles of carbon, typically created by burning fossil fuels, has been found in human placentas for the first time, in early-stage research at Queen Mary University London.

Previous research has indicated links between pregnant mothers' exposure to air pollution and complications including premature birth, low birth weight, childhood respiratory problems, and even infant mortality.

The new study, presented at the European Respiratory Society International Congress and funded by the charity Barts, suggests that when pregnant women breathe polluted air, sooty particles can reach the placenta via the bloodstream.

The work was presented by Dr Norrice Liu, a paediatrician and clinical research fellow, and Dr Lisa Miyashita, a post-doctoral researcher, both of Queen Mary's Blizard Institute.

Dr Miyashita said: "We've known for a while that air pollution affects foetal development and can continue to affect babies after birth and throughout their lives.

"We were interested to see if these effects could be due to pollution particles moving from the mother's lungs to the placenta. Until now, there has been very little evidence that inhaled particles get into the blood from the lung."

The researchers worked with five pregnant women who were all living in London and due to have planned caesarean section deliveries at the Royal London Hospital. They were all non-smokers with uncomplicated pregnancies and each one gave birth to a healthy baby. The women all gave permission for researchers to study their placentas after delivery.

The team was interested cells called placental macrophages. Macrophages are part of the body's immune system and work by engulfing harmful particles, such as bacteria and pollution particles. In the placenta they also help to protect the foetus.

The team studied a total of 3,500 placental macrophage cells from the five placentas and examined them under a high-powered microscope. They found 60 cells that between them contained 72 small black areas the researchers believed were carbon particles.

They went on to study the placental macrophages from two placentas in greater details using an electron microscope and again found material that they believe was made up of tiny carbon particles.

Dr Liu added: "We do not know whether the particles we found could also move across into the foetus, but our evidence suggests that this is indeed possible. We also know that the particles do not need to get into the baby's body to have an adverse effect, because if they have an effect on the placenta, this will have a direct impact on the foetus." ■

Plymouth estate is UK's largest passive-certified scheme

Primrose Park, a 72-home development in Whitleigh, Plymouth, has become the largest passive house certified residential development in the UK. The scheme, developed by Plymouth Community Homes in partnership with the local city council, features 49 dwellings for affordable rent and 23 in shared ownership. It was built using traditional masonry construction for a cost of £10.4m, with the elevated terrain requiring the construction of massive retaining walls and a bespoke drainage system.

"We're happy to do our bit in tackling fuel poverty and we're thankful to Mi-space and Plymouth City Council for working with us to make this happen. We hope residents enjoy living here for years to come," John Clarke, chief executive of Plymouth Community Homes, said of the project.

Designed by Mitchell Architects and built by contractor Mi-space, the project featured WARM: Low Energy Building Practice as passive house consultants and was certified by Etude. ■

19 major cities commit to zero carbon buildings

London has joined 18 other cities around the world, including Paris, New York and Tokyo, in a landmark commitment to make all new buildings "zero carbon" by 2030. Regulations and planning policy will also target existing buildings to make them net-zero carbon by 2050.

The commitment has been orchestrated by C40 cities, a global group of major cities committed to delivering on the most ambitious goals of the Paris Agreement at the local level.

As city authorities do not have direct control over all the buildings in their area, the commitment includes a pledge to work together with the private sector as well as state and regional governments to drive the transformation.

The C40 cities defined net zero buildings as those which "use energy ultra-efficiently and meet any remaining energy needs from renewable sources". This pledge from cities is part of the World Green Building Council's net zero carbon buildings commitment for businesses, cities, states and regions, which launched in June.

Cities making this commitment will have to establish a roadmap for reaching net zero carbon buildings, develop a suite of supporting incentives and programmes, report annually on progress towards meeting the targets, and evaluate the feasibility of reporting on emissions beyond operational carbon (such as refrigerants).

The other cities to sign the pledge are Copenhagen, Johannesburg, Los Angeles, Montreal, Newburyport, Portland, San Francisco, San Jose, Santa Monica, Stockholm, Sydney, Toronto, Tshwane, Vancouver and Washington DC.

"This commitment from a powerful group of cities across the globe is arguably the strongest indicator yet that, in the absence of policy leadership from national governments, it is city regions that are showing true leadership by stepping-up to take action on climate change," said UKGBC chief executive Julie Hirigoyen.

At the UK level, earlier this year, UKGBC co-ordinated an open letter to the government calling for the 2030 target to be adopted nationally. The letter was signed by over 50 influential business leaders from across the construction and property industry.

For more details **see www.c40.org**. ■

(above) New York is one of 19 cities to sign the zero carbon pledge.

Bere: architects gets RIBA nod for 'house as power station' research

Image: bere:architects

(above) Lark Rise passive house.

Bere:architects have been shortlisted for the 2018 RIBA President's Awards for Research, for their work on the viability of the 'house power station' concept at the Lark Rise passive house in Buckinghamshire.

"Our hypothesis is that housing can generate an excess of energy for at least 9 months of the year, use at least 90% less winter energy, avoid drawing peak load energy from the grid (peak load being the main determinant of total power station capacity) and be a balancing element on the grid," read a statement from bere:architects on the RIBA website.

"If our hypothesis is proved correct, it raises the question whether money allocated for constructing power stations may instead be more productively spent on improving buildings? If implemented at scale, it might be cheaper to reduce energy demand per kWh in housing than increase supply by new power stations. Zero carbon power export to the grid would be a bonus."

Lark Rise is certified to the passive house plus standard and was built to minimise all-year energy demand, maximise energy production and optimise energy storage. The house features a 12kWp solar photovoltaic array and a 13kW battery to store solar energy. Bere said its findings had been described by one grid expert as "game changing". The firm said: "The prototype building was found to have 98% less demand per m2 from the grid (for all energy uses including heating and power sockets) than a standard UK building, it was found to draw from the grid only 2% of [the energy of] an ordinary house while exporting 10 times as much energy to the national grid as it imports each year."

The RIBA President's Awards for Research celebrates the best research in the fields of architecture and the built environment, and have again attracted interest from countries around the globe with entries from New Zealand, Pakistan, Germany, the USA, and Chile, among other countries.

This year's shortlist includes papers on design and rehabilitation in prisons, architects and architecture in conflict zones, urban refugees in Cape Town, and regulating architecture and regaining 'agency' over projects and outcomes. The winning papers and medallist will be announced at this year's president's medals ceremony at the RIBA on the 4 December 2018. ■

The international style: performance vs pattern

In his latest column on the evolution of sustainable building design in the 20th century, Dr Marc Ó Riain looks at some early modernists who wanted their buildings to respond to local climate — and some who didn't.

It is easy to allege that the international style had a negative impact on the environment, and that its protagonists were exclusively concerned with form over such utilitarian concerns as climate. With some of its buildings over 100 years old, North America suffers from the world's largest CO2 footprint and its modernist architectural heritage is in the dock for disconnecting form from function.

The interwar period (1919-1939) saw the migration of the European international style to the UK, then onto North America, where it was criticised by such luminaries as Frank Lloyd Wright in 1930, who accused this "superficial, new 'surface and mass' aesthetic" of creating "badly built"…"cardboard houses"… "folded and bent in rectangles… glued together in boxlike forms…" unresponsive to their local contexts (Wright 1945).

Yet concurrently some of Wright's peers in Europe were either evolving the international style to respond to climate or indeed uncoupling the form from its interior climate.

Raoul Decourt's "maison isotherme" (isothermal house, 1925) was based on a machine for living, mechanically separating indoor and exterior climates. Such types of active air conditioning systems would later be introduced into cinemas (1920s), offices (1930s) and homes (1950s).

Radiant heating systems were integrated into floors, walls and ceilings by pioneering modernist architects such as Corbusier, Aalto and Duiker, whilst Frank Lloyd Wright was using underfloor heating, all before 1939. The technology of indoor climate control could free an architect to concentrate on form, whilst others sought to regionalise their buildings in the context of their climate.

Some modernists believed that climate was a logical evolution of the functionalist tradition, and that regional modernism could be a bioclimatic expression of a buildings' context. Mirroring the Keck brothers in the US, the Hungarian Olgyay twins took this bioclimatic approach to their architecture in the early 1940s with regionally responsive buildings. The Olgyays scientifically studied solar orientation, radiant heat transfer, time lag, micro-climatic effects, wind, exposure, and shading, whilst adopting heliothermic planning.

Exemplar projects such as their Budapest Tschögl apartment scheme (1940) and Stuhmer chocolate factory (1941) demonstrated that the modernist tradition and bioclimatic design were not mutually incongruent. Victor Olgyay had a significant impact on US architecture, becoming dean of architecture at Princeton in the 1950s and publishing 'Design with Climate: Bioclimatic Approach to Architectural Regionalism' in 1963.

The Tschögl apartment scheme, Budapest. Photo: Adrian Tschögl

Perhaps surprisingly to some, Corbusier appeared quite concerned with solar gain in 1933, when he redesigned a skyscraper for his proposed Cite Radieuse, by adopting fixed 'brise soleil' in a new section "dictated by sunlight" (Corbusier).

Corbusier also experimented with active systems on the City of Refuge (1933), using mechanically operated active double skin facades (murs neutralisants), mechanical ventilation with heat recovery (respiration exacte), and an air tightness that would be almost 60 years before passive house. Budget restrictions and mechanical failures caused summer overheating from solar gain, with intolerable living conditions for its homeless occupants, leading to performance failure.

In 1933 Corbusier also designed a block of flats in Algiers with sheer glass walls on the north and east sides, and brise soleil on the south and west elevations (Mackenzie 2011) … "the sun must never touch a pane of glass during the summer period, between the two equinoxes… the sun may be desirable at the winter solstice but be intolerable at the summer solstice. Therefore, fixed brises-soleils are not entirely appropriate" (Corbusier 1960). Such examples challenge the notion that all the protagonists of the international style were exclusively focused on form over function.

The European modernists brought both a new formal language and the beginnings of bioclimatic design to North America after WW2 to blend with indigenous practice. With the Olgyay brothers at Princeton, Mies at IIT Chicago, and Gropius at Harvard, European architects would establish different paradigms for modernism in the US.

'Regional modernism' (Gropius, Olgyay, Wright) and the purist International style (Mies) fought for dominance. The international style adopted active technologies to free its architecture from the concerns and limitations of climate, thus allowing for transparency and the dogmatic articulation of structure and grid. This found favour with companies who wished to express their industrial egos through puritanical and inefficient glass and steel buildings, which would go on to define the US skyline for the next century.

In the next article we will look at how a group of indigenous architects responded to the need for post war housing in the UK and US. ■

> The international style adopted active technologies to free its architecture from the concerns and limitations of climate.

Dr Marc Ó Riain is the president emeritus of the Institute of Designers in Ireland, a founding editor of Iterations design research journal and practice review, a former director of Irish Design 2015, a board member of the new Design Enterprise Skillsnet and has completed a PhD in low energy building retrofit, realising Ireland's first commercial NZEB retrofit in 2013.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DEEP GREEN PASSIVE HOUSE

DEFIES ALL WEATHER

With Old Holloway Cottage, located in rural Herefordshire, architect Juraj Mikurcik and his wife Joyce have lovingly crafted a beautiful-yet-simple passive home that is constructed from timber, insulated with straw, and finished with a palette of natural, durable materials — and all for a surprisingly small budget.

Words by Kate De Selincourt

£0

for space heating

(spent so far on timber for wood burning stove, see 'In detail' for more)

Building:
99 sqm timber frame bungalow

Location: Little Birch, Herefordshire

Completed: October 2017

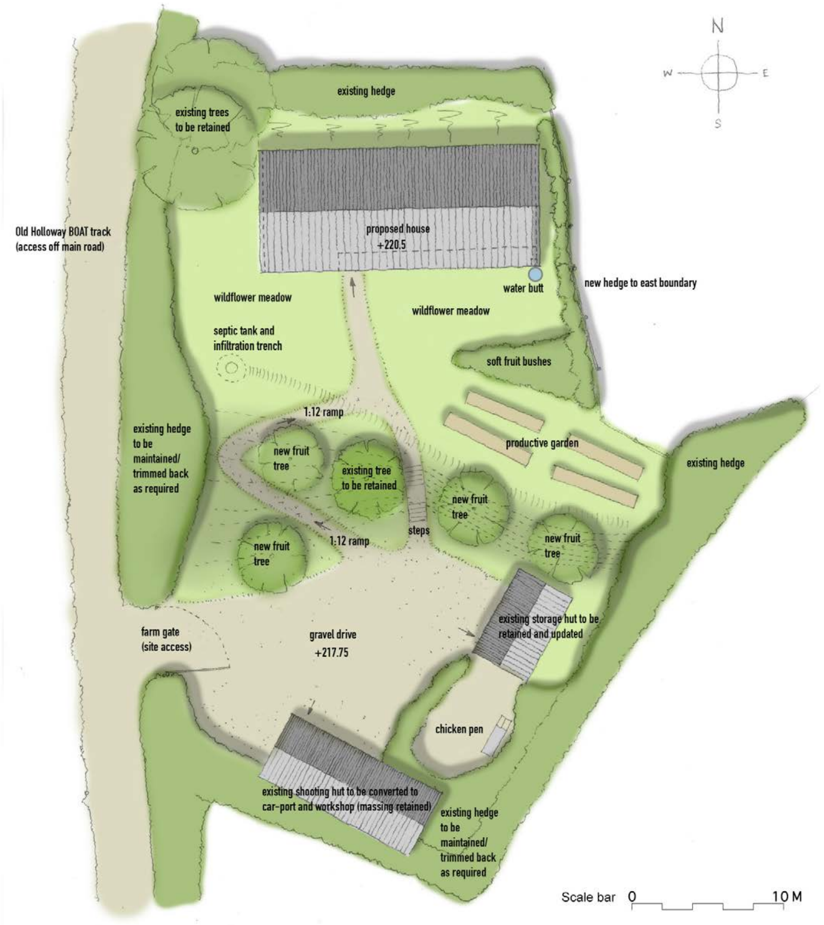
Cost: £135,000
(construction only, including VAT rebate)

Standard: Passive house certified

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie



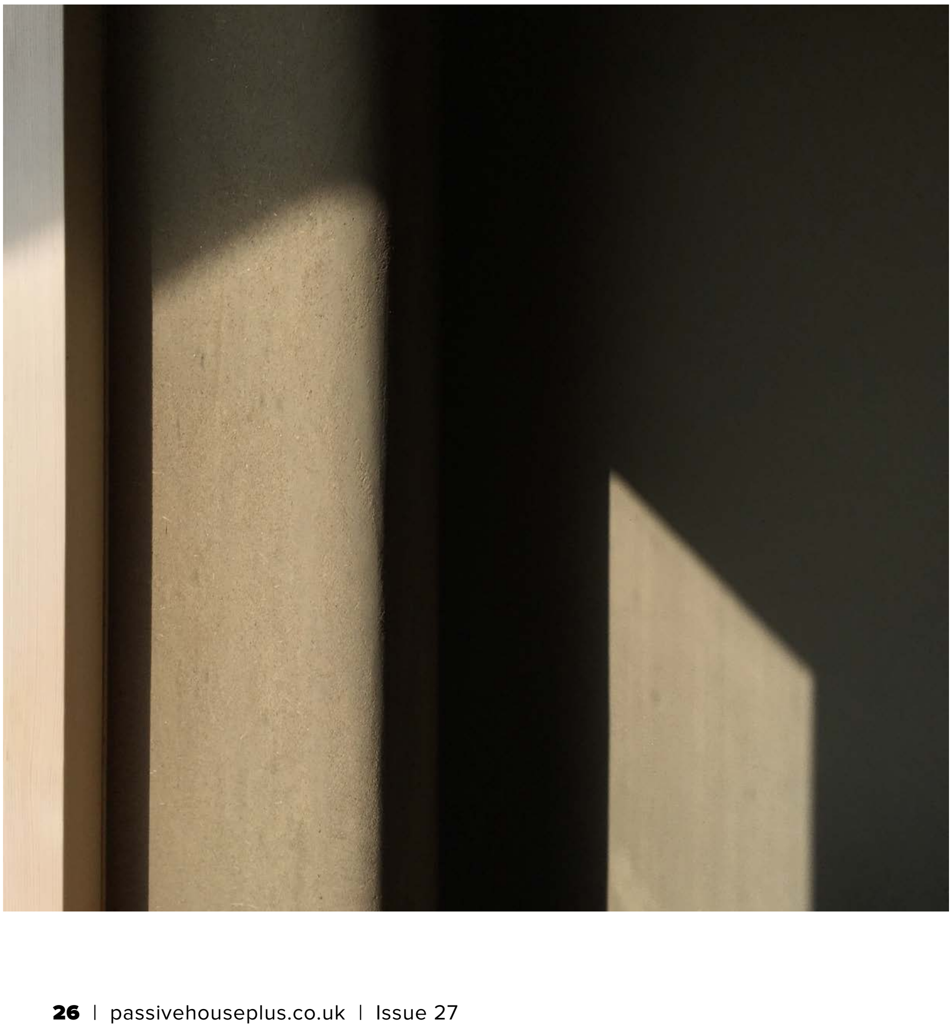
Having designed a number of passive house buildings for his employer Architype while enduring life in a chilly old cottage that cost £1,500 each winter to heat, architect Juraj Mikurcik and his wife Joyce Freeman had been dreaming of building their own passive house.

Affordable plots for self-builds are a rare find in rural Herefordshire, but Juraj and Joyce were lucky enough to find the perfect site, by complete chance – they happened to pass it on a bike ride. The site, on a south facing slope with wonderful views out over the countryside, looked unused. And it was: it turned out to house a redundant shooting hut belonging to the Duchy of Cornwall, who are also Architype's landlord at their nearby Upper Twyford office (the Duchy owns a lot of land in the area).

The Duchy agreed to sell the land, but Juraj and Joyce would have to get its approval for their design before the house was submitted for planning permission.

The Duchy required the building to look simple and modest – the former shooting hut was a low-roofed timber shed, and they wanted the house to reflect this agricultural aesthetic. This ruled out Juraj's original, more overtly contemporary design with its monopitch green roof and distinctive glazing.

The Duchy's stipulations worked to Juraj and Joyce's advantage though, as valuation of the plot reflected the fact that though



quite large, it was only going to accommodate one modest three-bed home, and not the three-garage McMansion (or two) that might otherwise have been built on a plot of this size.

Juraj and Joyce were keen to build at the top of the plot, to take maximum advantage of the view. As there is a house behind them, they were limited to a single storey so as not to impinge excessively on their neighbours.

The design they settled on was a long, low, timber clad bungalow with a simple corrugated steel roof, the timber to be charred, and the roof painted black – a look Juraj liked, and also one that helped the building recede visually into its surroundings, in line with the Duchy's preferences.

Small detached bungalows inevitably have pretty poor form factors, and with a ratio of 4.6 this one is certainly not ideal for a passive house (see 'Explained'). But Juraj and Joyce did manage to achieve the standard without appearing to strain either the design or the choice of materials.

Straw and timber construction

For the build, Juraj was keen to try a modular, prefabricated straw-and-timber system called Ecococon that's manufactured in Lithuania. "I encountered Ecococon via my friend Bjørn Kierulf in Slovakia, he had been using it for the past five years or so," he says.

"From our point of view, it combines low impact, renewable materials with accuracy and speed. I had tried to specify this system on previous Architype projects, to no avail, so this was the perfect opportunity to try it out – and we were the first to use the system in the UK."

Although committed to the use of natural materials, and in particular timber (the material most favoured by Architype), Juraj is not keen on the slightly 'hollow' finish he feels you sometimes get from timber frame with plasterboard linings.

"I wanted to achieve a solid feel to the house if possible. Coming from central Europe I'm quite used to masonry buildings. The clay plaster applied straight on to Ecococon panels creates a really solid wall. Also the Fermacell linings applied to internal partitions are double the density of standard plasterboard, so the building ends up feeling a lot more solid."

Ecococon is a screw-together modular system, comprising wooden frames densely packed with straw to achieve precise sizing, and consistent thermal and moisture properties.

End panels and window reveals are faced with 12mm plywood, but otherwise the timber structure does not cross the straw layer, minimising thermal bridging, and enabling the system to achieve passive house certification.

Everything in Juraj's design was sized to fit Ecococon's standard 600mm and 800mm modules, which proved much more cost-effective than getting bespoke module sizes made up. The design was all communicated in the SketchUp 3D modelling software, and Ecococon supplied a colour-coded set of build instructions.

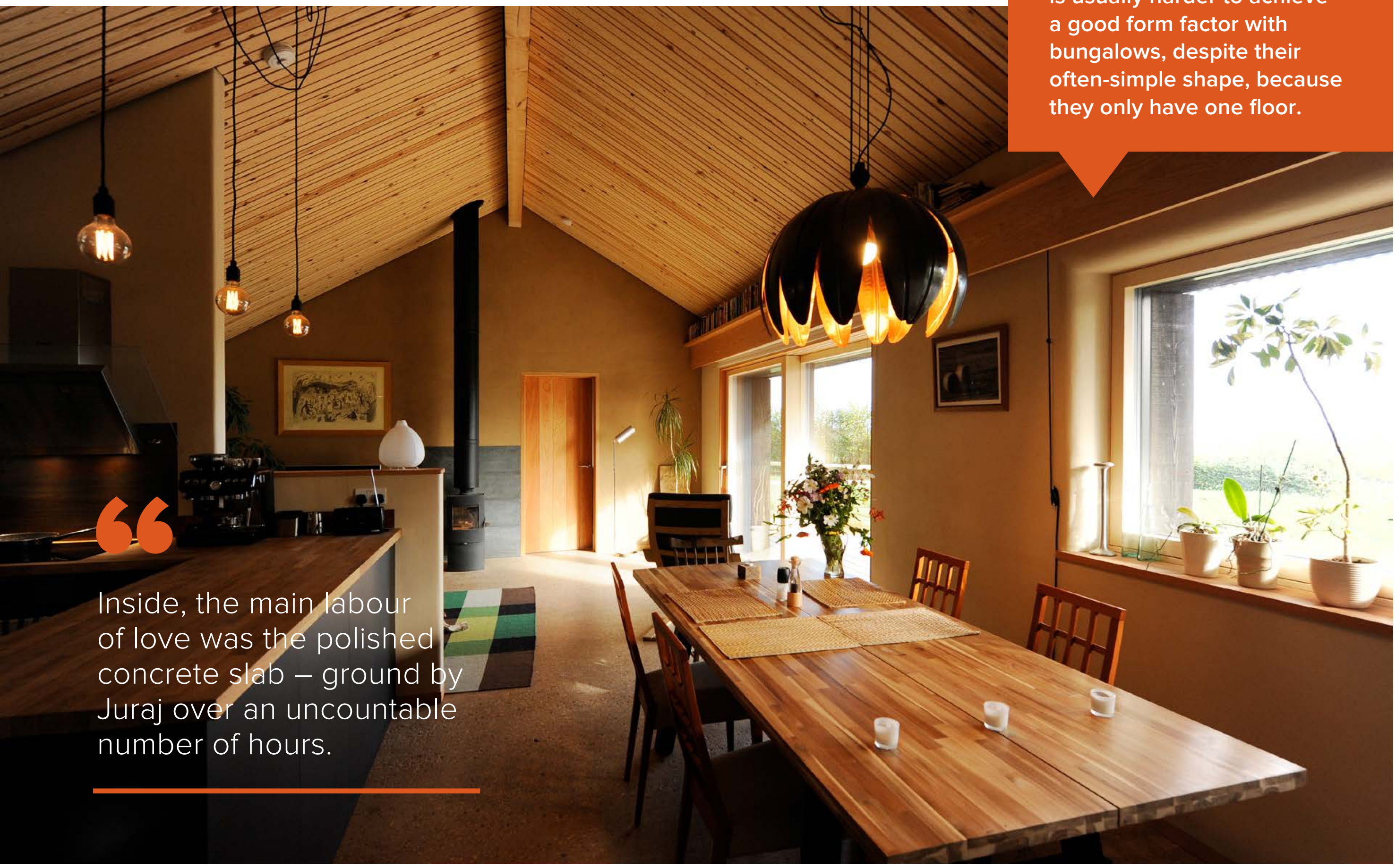
Structure and insulation

To achieve the passive house standard, the insulating performance of roof and walls had to be increased slightly on Ecococon's standard spec, but this worked well with other aspects of the design.

For example, as Juraj and Joyce were building to the passive house standard, the Ecococon system required an airtightness membrane sitting outside the straw layer (so the clay plaster could be applied directly to the straw internally). This in turn

Explained

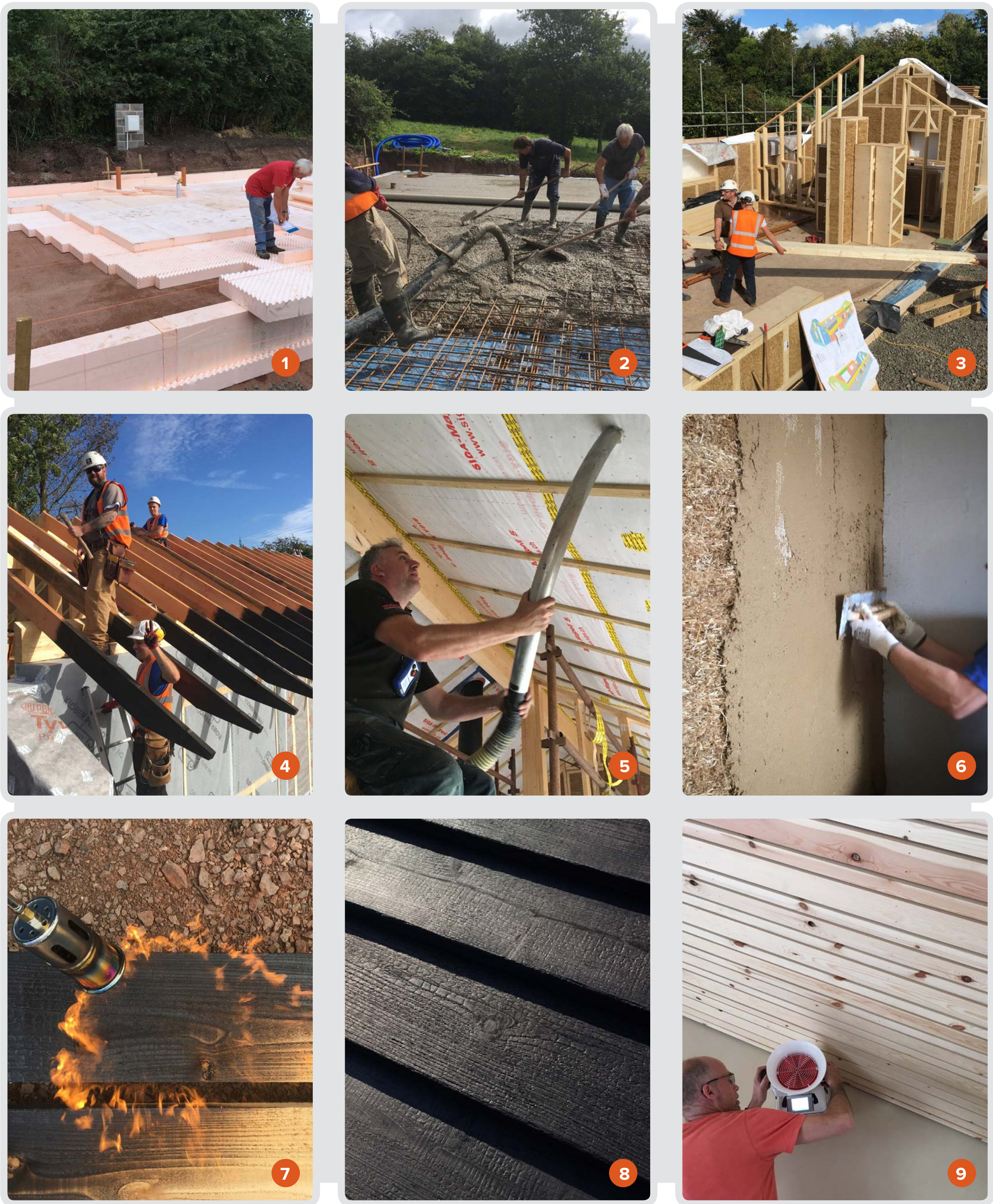
Form factor is the ratio of a building's total surface area (the walls, roof and ground floor) to its treated floor area. The smaller the form factor, the more efficient the shape of the building and the less surface area from which heat can escape. A form factor of under 3.0 is considered ideal for a passive house. It is usually harder to achieve a good form factor with bungalows, despite their often-simple shape, because they only have one floor.



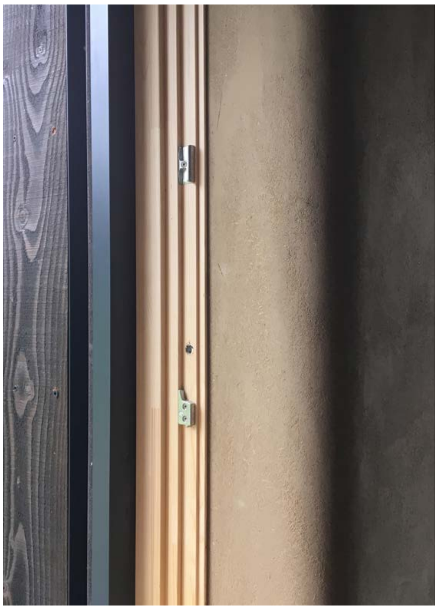
Inside, the main labour of love was the polished concrete slab – ground by Juraj over an uncountable number of hours.

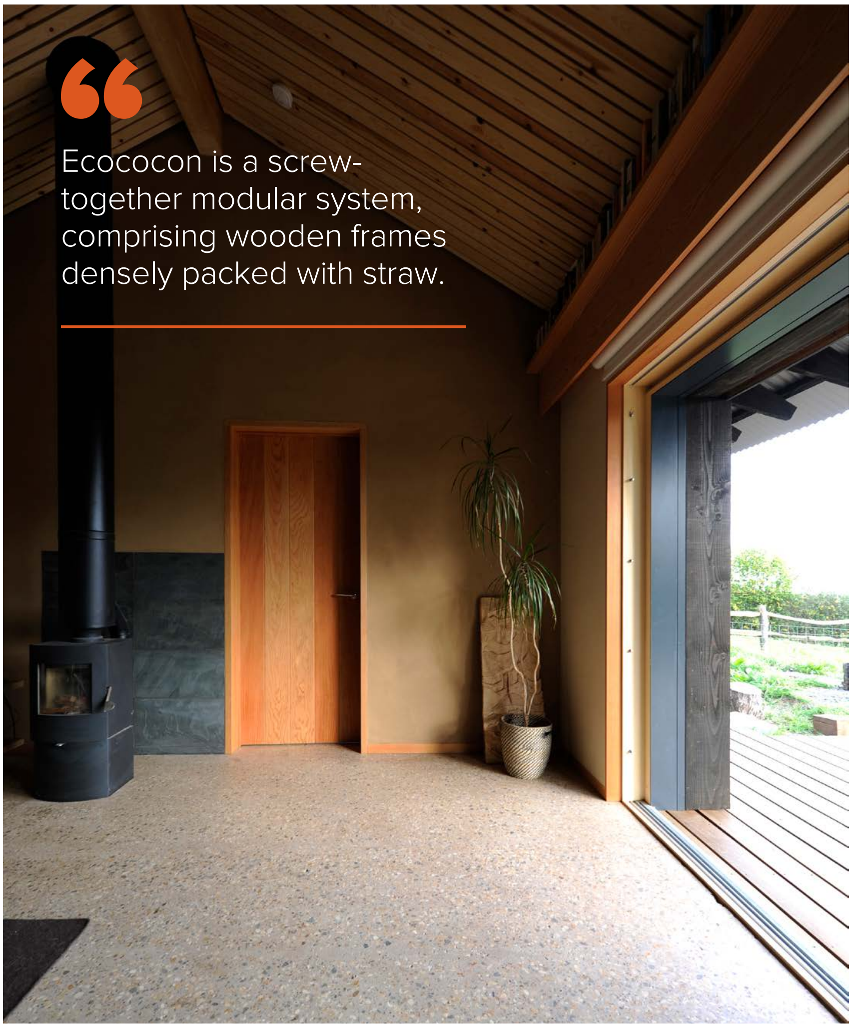
Photography: Juraj Mikurcik

CONSTRUCTION IN PROGRESS



1 Installing the 250mm Isoquick EPS insulated foundation system; **2** pouring the concrete slab; **3** the walls of the house were built using Ecococon, a modular prefabricated straw-and-timber system; **4** Econocon also supplied the roof system, which features I-joists and a thermal-bridge free cantilevered roof overhang along the south; **5** cellulose expert Gordon Lewis pump-filling the Warmcel cellulose insulation into the roof; **6** internal clay plastering directly onto the straw, with reinforcing mesh visible; **7 & 8** the locally-sourced cedar cladding was all charred on-site with a blowtorch, to give a pleasing, slightly-textured, and highly durable finish; **9** Alan Clarke commissioning the ventilation system.





made it necessary to add wood-fibre boards to the outside of the straw and membrane, otherwise a sharp temperature drop could have created a risk of interstitial condensation here. But this extra layer of insulation also brought the wall U-value down to what was required to meet passive house requirements.

To get a low enough U-value in the roof, I-joists were used, fully filled with 400mm of Warmcel. "On the plus side this allowed us to achieve a thermal bridge-free cantilevered roof overhang along the south, because there was enough depth to incorporate rafters without bridging right across the roof insulation," Juraj says.

Ecococon designed and supplied all the roof structure, including pre-sawn beams, wall plates and so on. "There was only one main delivery to worry about, and I wanted to keep the structural packages with one subcontractor rather than splitting it up and risking finger pointing if anything didn't fit. I'd recommend this approach every time," he says.

The floor construction is an Isoquick raft system, essentially a tub of EPS insulation with a concrete slab poured above and within the insulation. Compacfoam high density EPS is installed within the system under door thresholds to support their weight.

The straw panels were set out from the floor slab in order to align the straw layer with the returns of the under-slab insulation. Ecococon confirmed that the panels would comfortably support the roof with this arrangement.

Passive performance

For winter warmth and comfort, alongside the high levels of insulation, low thermal bridging and airtightness, the bungalow employs extensive south glazing.

High performance windows are not cheap, but oh, they are lovely to have. They will never be as well-insulated as a passive house wall though, so it is crucial to design glazing carefully: overdoing it quickly blows the financial and energy budgets, and risks summer overheating too.

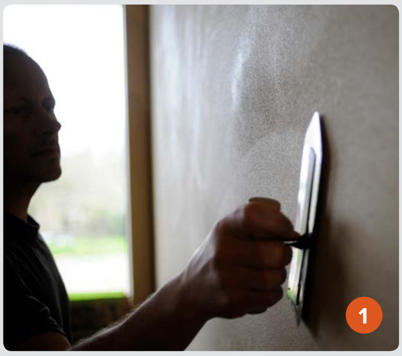
"We've used a few ground rules for window design: keep things simple, minimise mullions [the vertical bars between panes of glass], have opening lights only where needed, keep sizes to sensible dimensions, and provide adequate shading."

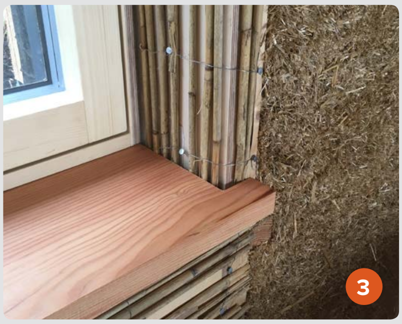
Nonetheless, Juraj and Joyce could not resist including large sliding glass doors in the main living area. "Luckily we were able to orientate the house facing perfect due south, which allowed us to design in shading relatively easily, while enjoying a lot of solar gains in winter."

The large roof overhang along the south of the house provides simple and effective shading without any need for blinds, and it extends the usable living space too. "Great for informal sitting, chilling and eating," Juraj says.

The one south window that is not shaded by the roof has an integral external roller blind. The windows also have deep reveals to cut 'sideways' solar gain during summer mornings and evenings, while east and west windows also have manually operated roller blinds.

The clay plaster and Fermacell-lined partitions mean that despite the timber ▶





and straw, the house is not a lightweight construction, and these heavier building elements provide thermal mass that can help to smooth out internal temperatures by absorbing heat and releasing it slowly.

But the majority of the thermal buffering is provided by the exposed slab: "We chose to use a concrete slab as the base for our house for a couple of reasons: once ground down, it would provide a durable finished floor surface, and it would provide useful thermal mass in an otherwise medium density construction."

The exposed concrete helps to moderate daytime peaks, but as Juraj points out, with thermal mass, adequate provision for 'night purging' is essential to ensure heat does not build up. He can achieve this by opening all windows at night, providing good cross ventilation. Metal mesh fly screens over the bedroom windows enable night ventilation without insects getting in — and also add privacy and cut out some solar gain during the day. This works so well that Juraj and Joyce have retrofitted similar screens to other windows.

Wood-burning stove

Not much space heating is required, and most is provided by a small 4kW wood-burning stove in the main living space – something Juraj wanted to indulge in, despite the inevitable extra fiddle of installing a stove in an airtight building (eased here by using a single flue with separate, in and out channels like the balanced flue for a gas boiler). The stove heats the house directly – there is no back boiler or underfloor heating.

Top-up space heating — to bathroom towel rails only — and hot water is supplied by an Ariston 200L hot water cylinder that is heated by an integrated air source heat pump. The heat pump runs for about a third of the time in winter, much less in summer, and is quiet, with a hum similar to a fridge. The Zehnder ComfoAir160 heat recovery ventilation system is also pretty much inaudible.

The build

The main contractor on the project was legendary local builder and passive house specialist Mike Whitfield. The Ecococon system was a first for Mike, who generally builds his own timber frame structures on site, but he was happy to give something new a go here.

Juraj was impressed by the speed of construction. "It took us only three days to assemble all the external walls, two internal load bearing walls and the main glulam ridge beam," he says. Everything fitted perfectly, Juraj says, and the building was watertight in just four weeks.

Nevertheless in the short period at the start before the roof and external sheathing went on, the structure was very vulnerable to any rain, making those weeks "a bit hairy", as Mike put it. The structure had to be kept meticulously covered. In one small spot the wrapping must have failed, as Juraj later found that a patch of straw had sprouted, and had to be removed and replaced with cellulose insulation.

The modular system was easier to handle than full-sized timber panels would have been – the biggest section weighed around 120kg (this was less than half the weight of the glass sliding doors, which had to be unloaded at a nearby industrial estate). Most of the panels weighed around 60-70kg, so were relatively easy to move. The combination of a modular system and single-storey construction thus averted the need for lifting equipment. Given that access was tight, this was a great advantage.

Mike's reputation for meticulous detailing was borne out with the airtightness result of 0.38 air changes per hour. "Bearing in mind the unfavourable form factor, and the fact that we used mainly membranes for airtightness – and fitted a wood stove – we were really pleased. It really is a credit to the whole Mike Whitfield building team," Juraj says.

Natural finishes

The use of low toxicity, natural materials was very important to Juraj and Joyce, and they have put together a relatively small number of lovely materials, to great effect.

On the outside of the house, the charred finish was something Juraj had always wanted to try, but never persuaded a client to specify. The locally-sourced cedar cladding was all charred on-site with a blowtorch, by Juraj and a couple of friends to give a pleasing, slightly-textured, and highly durable finish.

Of course many designers enjoy the chance to be truly hands-on, and Juraj made the absolute most of the opportunity. Inside, the main labour of love was the polished concrete slab – ground by Juraj over an uncountable number of hours. But the beauty of the innumerable colours of the stones shining through the sealed finish is unarguable.

Also very hands-on was the clay plastering. Juraj got the chance to work alongside an expert, Roman Miškov from Slovakia, and

Natural materials were specified throughout the house, including: **1&2** the internal clay plaster; **3** the straw-insulated walls with reed mat reinforcement; **3** the charred cedar cladding and **4** Douglas fir for internal doors.

the two of them completed the plastering together. The clay is mixed with natural pigments to give several soft, earthy colours – and for some of the walls, the finish included chopped straw, which adds a lovely hint of sparkle when the light catches it.

Above the main living area, the cathedral ceiling is softened with a pattern of untreated redwood battens, which also help with acoustics. And apart from the insulation under the slab, and the seal on its surface, very few petrochemical products were used in this build.

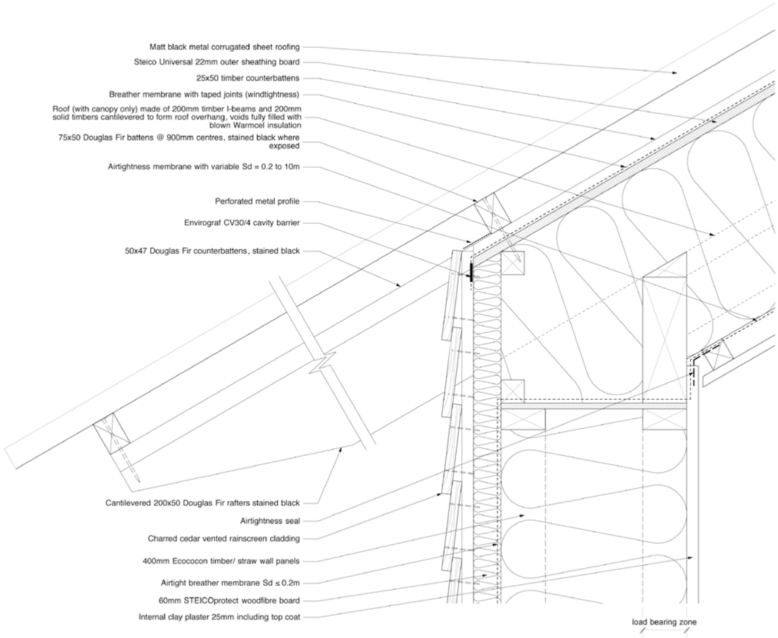
The clay plasters are either left natural or finished with natural pigments. Exposed timber is oiled with Osmo oil, and Auro paints were used on plasterboard ceilings – both these product ranges are mainly plant-based, or use natural products such as milk casein.

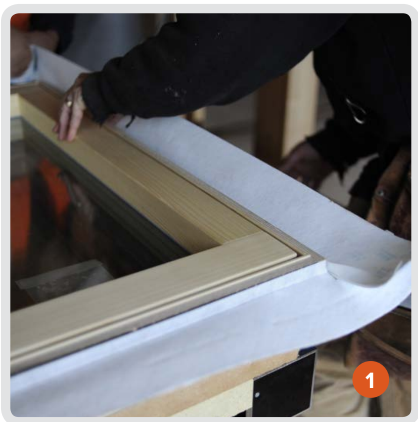
Wonderful – but how affordable?

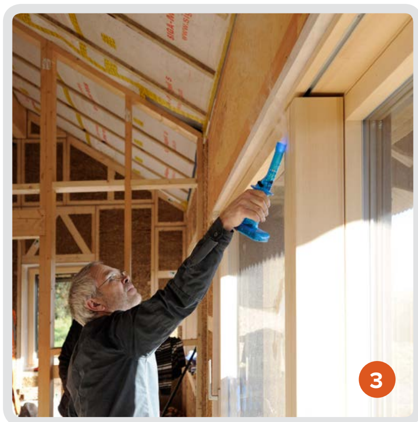
As well as quite a bit of hands-on involvement with the build, a lot of time was spent creating the very particular finishes — the clay plaster, charred wood and polished concrete — making it very much Juraj and Joyce's house.

The construction costs have been totted up by Juraj as coming to £150,000 (£135,000 after a VAT refund, as they were self-builders) for a 99 square metre house. It's always tricky to compare costs across projects, but with its simple, modest form, a passive house build of similar design realised via more familiar construction methods, for a client who did not want to get so involved on site, should be at least as affordable.

So many self-build projects run away with themselves and end up larger, and therefore more expensive than really makes sense. "My top tip to self-builders is: re-evaluate how much space you actually need," Juraj says. The smaller the build, the more detailed control you will have, and the more budget you'll have left to spend on the best components, on beautiful finishes – or indeed, on just enjoying life in your new home.







1 Airtightness tapes pre-fitted on Smartwin passive house certified timber windows; **2** plywood box window reveals; **3** energy consultant Nick Grant uses a smoke pencil to look for air leakages around the windows.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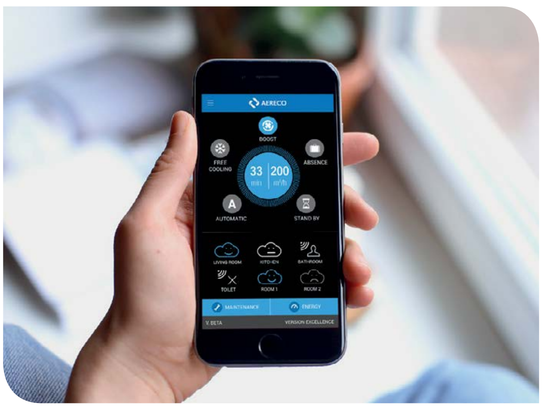


SELECTED PROJECT DETAILS

Clients: Juraj Mikurcik & Joyce Freeman
Architect & passive house consultant: Juraj Mikurcik
Energy rating assessment: Energy Calculations Ltd
Passive house certifier: WARM
Timber frame: Ecococon
Timber frame technical support: Bjørn Kierulf/Createrra
Mechanical services consultants: Alan Clarke & Nick Grant
Contractor (up to lock-up stage): Mike Whitfield Construction Ltd
Mechanical contractor: Robert R McGowan Ltd
Electrical contractor: Monnow Electrical Services Ltd
Airtightness testing: Paul Jennings/Encraft & Melin
External woodfibre insulation: Steico, via Ecococon
Blown cellulose insulation: Warmcel, via PYC
Insulated foundation system: Isoquick UK
Thermal breaks: Compacfoam, via Green Building Store
Windows, doors & sliding doors: Smartwin, via Hoblina
Timber joinery: JM Joinery
Airtightness products: Siga & Pro Clima
MVHR: Zehnder, via Green Building Store
Wood burning stove: Morso S11-43, via Prince & Pugh
Stove flue: Poujoulat UK
Hot water cylinder w/integrated heat pump: Ariston Nuos 200, via Graham The Plumbers Merchant
Internal stud linings: Fermacell
Ceiling linings: British Gypsum
Flooring: FILA clear wax, via Mandarin Stone Monmouth
Clay plasters: Picas
Clay plasterer: Roman Miškov/Bioline
Timber cladding: Cilfiegan Sawmill
Timber decking: Vastern Timber
Timber cladding & decking fixings: Sigha, via Russwood
Pre-mixed concrete: Radbournes Hereford
Custom lights: Lock Lamp
Corrugated metal roofing: Thomas Panels & Profiles
Eco paints: Auro, via The Green Shop
Natural wood stains: OSMO, via Gibbs & Dandy
Finance: Ecology Building Society

LIVING IN OLD HOLLOWAY PASSIVE HOUSE

The first year threw extremes of both heat and cold at Old Holloway cottage – so how did it fare?

Juraj and Joyce moved in during the of summer 2017, but the house maintained a steady 20 to 21C, without heating, well into the autumn. It wasn't until November that they felt cold enough to light the stove, which they continued to do every couple of nights or so through the winter. They report that it generally only needs to burn for an hour if the sun has been out, but longer when the weather has been grey.

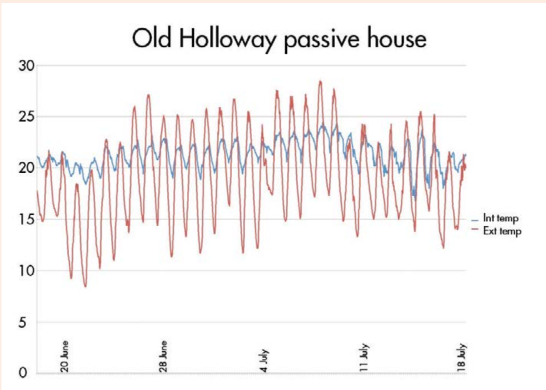
Even when the 'beast from the east' struck last February, indoor temperatures were remarkably even. Not only was that episode bitterly cold, it was also very windy: the kind of weather where airtightness comes into its own.

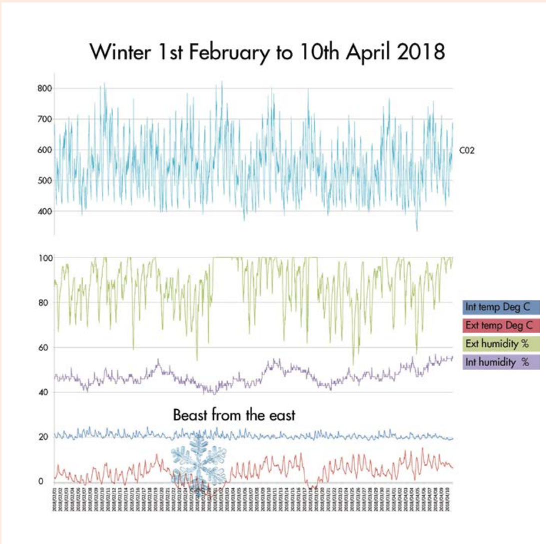
So far Joyce and Juraj haven't spent a penny on firewood, as the first winter only used up around one cubic metre of construction offcuts, and Juraj reckons there is another three winters' worth left — a dramatic contrast to costs at their previous home.

Between the south-facing glazing, the stove and any additional heat gains (e.g. from cooking), the living area tends to be a couple of degrees warmer than the bedrooms, which is how Juraj and Joyce — and indeed many people — like it.

And then of course there was 2018's summer. Passive House Plus visited the house on a warm muggy day, and it felt pleasantly cool inside. And this is borne out by the monitoring results. Overall, PHPP predicted 0% overheating, and despite this year's prolonged heatwave, this has been achieved, with internal temperatures remaining below 25C (the passive house definition of overheating) at all times.

While outside temperatures regularly hit 25C to 27C, inside the temperature generally peaked around 22C or 23C, with night purges bringing it back down to around 20C each night. As the hot weather carried on, indoor peaks to some extent reflected conditions at night: a spell in early July where night-time temperature lows outside started to edge upward saw indoor temperatures creep up too, towards 24C, but with outdoor daytime highs of 27 and 28, this still felt very comfortable, Juraj says.





IN DETAIL

Building type: 99 sqm timber frame bungalow

Location: Little Birch, Herefordshire, UK

Completion date: October 2017

Budget: £150,000 (£135,000 after tax rebate on materials for new self-build homes)

Passive house certification: Certified

Space heating demand (PHPP): 14.9 kWh/m²/yr

Heat load (PHPP): 12.0 W/m²

Primary energy demand (PHPP): 142 kWh/m²/yr

Heat loss form factor (PHPP): 4.54

Overheating (PHPP): 0%

Airtightness (at 50 Pascals): 0.38 ACH final air test

Energy performance certificate (EPC): C 78

Measured energy consumption: Calculated space heating demand based on 1m³ of burnt wood over the winter heating season (assumed calorific value 1,800kWh per tonne and weight of 500kg/m² timber) is 9.5 kWh/m²/yr. Ariston Nuos 200 water cylinder with integrated air source heat pump consumed 1,641 kWh or approx. 32kWh per week between July 2017 and July 2018, providing all domestic hot water and some space heating via towel rails in bathrooms for six months of the year. Difficult to estimate the portion of energy used for heating the towel rail as it is not sub-metered. Conservative estimate is approximately 15% of output to towel rails and 85% for domestic hot water.

Thermal bridging: Ecococon timber/ straw system is certified by the Passive House Institute with confirmed Y-values for typical junctions, most of which are negative. These values can simply be used in PHPP. Example: external wall corner has a Y-value of -0.089 W/mK. The junction between the wall and insulated slab was modeled using PSI Therm, with Y-value of -0.004 W/mK. Woodstove flue Y-value was assessed as 1.1 W/mK and thermal bridge through one insulated SVP as 0.28 W/mK. Doors are installed on Compacfoam EPS bearers (notched into Isoquick EPS foundation system) bolted to the edge of concrete slab. Window and door frames are partially insulated on the outside with wood fibre boards.

Energy bills (measured or estimated): Monthly electricity bill £55 (direct debit based on meter readings). This includes air source heat pump (providing domestic hot water and heated towel rails) and all domestic appliances, equipment and lighting.

Ground floor: 150mm compacted hardcore base followed above by 45mm sand blinding, 250mm Isoquick EPS insulated foundation system, 1mm DPM, 225mm reinforced concrete slab, ground finish & clear sealant. U-value: 0.095 W/m²K.

Walls: Rainscreen horizontal board on board timber cladding: 200x20 homegrown western red cedar from the Forest of Dean, charred on site. Majority of cladding is sealed with clear OSMO oil. All cladding fixed to 25x50mm vertical softwood battens using Sigha black finished 70mm long stainless-steel screws. Followed inside by Steico Protect T&G woodfibre board, stapled through Dupont Tyvek Pro airtight breather membrane to Ecococon panels. All joints in membrane taped with SIGA Wigluw tape. Ecococon timber-straw panels inside membrane, followed behind by internal clay plaster consisting of two 15mm coarse base coats with reinforcing mesh, 5mm fine undercoat and 1.5mm self-pigmented fine top coat with chopped straw for added sparkle. Reed mat reinforcement was applied to larger areas of timber (glulam lintels, ply window reveals) for improved key prior to plastering. U-value: 0.13 W/m²K.

Roof: Black factory painted corrugated steel sheet panels fixed to 75x50mm Douglas fir battens and 50x50mm softwood counterbattens, on SIGA Majcoat breather membrane, on 22mm Steico Universal woodfibre sheathing board. Roof rafters are 400mm deep Steico timber I-beams with gaps fully filled with Warmcel blown recycled cellulose. On the underside, SIGA Majpell 5 airtightness membrane is applied, with all joints taped with SIGA Sicrall 60 airtightness tape. Penetrations in membrane after installation of Warmcel sealed with SIGA Sicrall 170 airtightness tape. Uninsulated 50mm service void. Acoustic ceiling finish to the main open plan living space: hit & miss softwood battens of varying widths (50mm, 70mm and 100mm) and 20mm thickness, on black membrane. British Gypsum Wallboard plasterboard, taped & jointed to other spaces. Auro 321 Classic emission free emulsion paint on plasterboard. U-value of roof: 0.095 W/m²K

Windows, external doors, sliding doors: Smartwin passive house certified aluminium clad timber units, sealed with SIGA airtightness and wind-tightness tapes. Average window & door U-value: 0.76 W/m²K.

Heating: Main space heating system: Morso S11 4kW woodstove with Poujoulat Efficience triple wall flue. No radiators or underfloor heating. Secondary heating system: stainless steel towel rails in bathrooms, running off domestic hot water system on a separate circuit. Domestic hot water is provided via Ariston Nuos 200 water cylinder with integral air source heat pump.

Ventilation: Zehnder Comfoair 160 Luxe MVHR system (via Green Building Store), with Lindab circular spiral bound metal ducting. Cascade system, supplying fresh air to habitable rooms and extracting from bathroom, shower room, utility and kitchen. Automatic summer bypass on MVHR.

Blinds: Sunstop (CZ) manual external fabric blinds (semi-translucent) integrated with window frames.

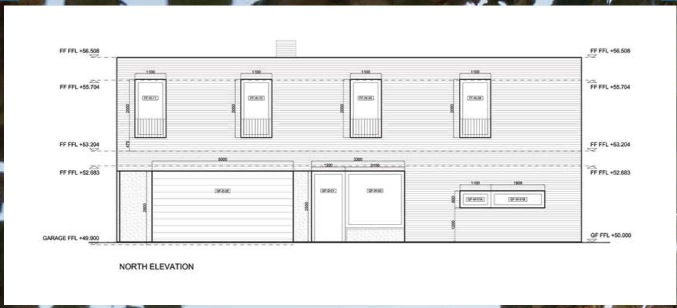
Green materials: Timber & straw wall panels; Fermacell dry lining boards; sheep wool, woodfibre and recycled cellulose insulation; clay plasters; barrier matting made from recycled tyres; locally sourced timber cladding; all timber sourced from PEFC/ FSC certified suppliers. ■

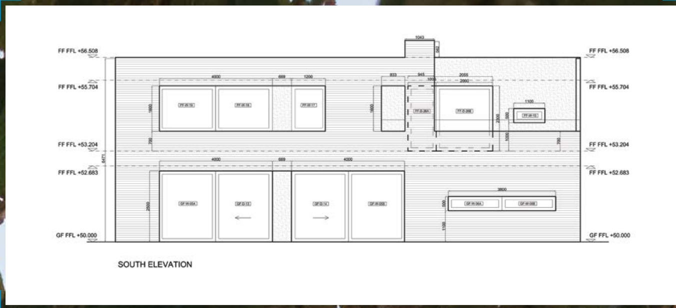
WOOD WORKS

SLEEK BUT LARGE HERTS PASSIVE HOUSE GOES HEAVY ON TIMBER

The Deerings, a large new certified passive house in the Hertfordshire village of Harpenden, is the stunning result of meticulous attention to design, energy efficiency and ecological materials by its architects, builders and a homeowner so taken by the experience that it led to an investment in an innovative passive house start-up.

Words by Jason Walsh





£0

for space heating

(see 'In detail' panel for more)

Building: 400 sqm timber frame passive house

Location: Harpenden, Hertfordshire

Completed: October 2017

Standard: Passive house certified

Originally from North Wales, Danny Luhde-Thompson had initially intended to move back there and build a new home, but when circumstances changed so did his plans. Rather than retreating to the country life, Luhde-Thompson and his wife ended up staying in their current home town of Harpenden in Hertfordshire, electing to demolish their bungalow in favour of a new, modernist-inspired five-bedroom house.

His childhood in Wales did mean one thing, though: Luhde-Thompson was sure that he wanted a house that took energy use and comfort into consideration. "As a child I lived in a long cold stone house with ice on the windows in the mornings," he says.

Wishing to avoid this ever again, Luhde-Thompson wanted a house that had the best possible thermal performance. Perhaps inevitably, it became a passive house. "Once you start looking into it, it's about more than just insulation; it's about airtightness and thermal bridging. When you keep going you end up with a passive house."

When Luhde-Thompson moved into the original building on the site —as he puts it, a typical 1970s bungalow—he attempted remedial work, and while this improved the dwelling it was also part of what inexorably drove his desire to build a passive house.

"I added insulation, and that definitely made a difference, but you come to realise there are problems you can't solve: cold bridges, damp patches and so on. It got kind of annoying, frankly."

Over the years Luhde-Thompson spent a lot of time researching the best way to achieve an energy efficient dwelling, and by the time he started to plan his build in Harpenden, passive house had become a realistic goal, with more expertise and know-how available.

Luhde-Thompson says that the process was not a particularly challenging one. "Because we knew we wanted it to be a passive house right from the start and because we had a south facing plot it was relatively easy. We were able to minimise north facing glass," he says.

He has already felt the benefits, saying that aside from having spent essentially nothing on space heating, the house is simply more comfortable than the norm.

The blistering summer of 2018 did throw up potential difficulties, however. How would a passive house deal with weather that saw all of Europe baking?

"The hot summer was much more of a challenge, it's true," he says. ""You have to have a strategy. Basically, you need to move the blinds and remember to open the windows in the evening [but] if you can get the house down to 23 or 24 [degrees] overnight you only gain a degree or two during the day."

Other difficulties were the result of conscious design choices. "We wanted a contemporary style, which was fine [but] some of the detailing work was pretty hard for the architect. Log-burning stoves in a passive house are pretty weird, but we liked the feel of sitting around one in the winter. Some of the routing through the chimney was pretty complicated," he says.

For architect Tom Gresford. this was his second fully certified passive house, and for

> You're not just getting something that performs well, you're also getting a beautifully-designed building.

his practice, Gresford Architects, marrying energy performance with good design is a central goal. Sometimes it is met with resistance, though.

"I don't think people take global warming seriously enough. This is me getting on my high horse, but [most] people want something sexy more [than they want a low energy home]," he says.

"We always try to get our clients to go to passive house; we're not always successful, but we always try. We like to marry that with a real concern for aesthetics."

Selling clients the idea of a house with lower running costs doesn't necessarily work, he says. "The problem with the cost issues is that people who are building the houses are relatively wealthy anyway."

Nonetheless, Gresford intends to keep banging the drum. "For us, we're saying to people that part of our unique selling point is that we are very design-conscious. You're not just getting something that performs well, you're also getting a beautifully-designed building."

Gresford says that an element of compromise is to be expected, but that does not mean the passive house standard cannot be achieved.

"If you're willing to engage [then] you can get there. That's one of the things I like about passive house: you're either getting it or you're not. There's no fudge in the certification."

The Deerings, a timber-frame construction, adopted a 'fabric-first' design approach while aiming to meet the client's aspirations in terms of space and lifestyle.

The super-insulated timber frame was constructed off-site by passive house veterans MBC Timber Frame, supplied with insulation and an airtight membrane, and erected in three weeks on a KORE passive slab, also provided by MBC.

"The MBC airtightness guarantee does remove a lot of the pain, because they absorb that headache," says Mike Jacob of Trunk Low Energy Building, who project managed the build.

This is the fourth passive house Jacob has worked on with Gresford Architects, and he says that preserving airtightness while installing the flue for the stove, after MBC had finished on site, was the biggest challenge on the job.

"In terms of thermal bridging that was really dealt with at the design stage. The garage was tricky, the roof terrace was tricky, but those problems were ironed out before it came to site," he says. "So, it was more about the service penetrations, particularly the flue."

Gresford agrees: "Wood-burning stoves have issues with airtightness and cold bridging," he says. "The average one is about as airtight as a sieve. The other [airtightness issue] was the cat flap. We went for an automatic cat flap, with a chip to open it."

Meanwhile cellulose insulation and external sweet chestnut cladding was chosen to help reduce the carbon footprint of the project, which minimised the use of concrete and steel to less than ten per cent of the total volume of the building.

Attention to the embodied energy in the materials was not only of interest to an environmentally-conscious client, but

> It's about more than just insulation; it's about airtightness and thermal bridging.

Photography: Quintin Lake

CONSTRUCTION IN PROGRESS

1 One-wire sensors installed throughout the house, like this one in the KORE insulated foundation system, monitor temperature and in some cases humidity; **2** construction of internal partitions in the timber-frame house underway; **3** I-Beam timber joists were fully insulated with Warmcel insulation with some mineral wool below, as seen here, followed beneath by a Pro Clima Intello Plus vapour control layer; **4** Solitex Fronta WA wind tight breather membrane to the outside of the timber-frame construction; **5** construction of the chimney for the wood-burning stove; **6** timber battens forming the rainscreen cavity to the outside of the wall build-up, onto which sweet chestnut cladding was fitted externally; **7** a boxed-off section of extra insulation installed due to the proximity of this area to the roof terrace; **8** timber battens forming a services void in the ceiling through which the rigid MVHR ductwork runs; **9** another one-wire temperature sensor installed within the timber-frame.

> As a child I lived in a long cold stone house with ice on the windows.

something that Gresford generally works into his designs. "Our previous passive house went completely without steel," he says.

"It was purely timber frame, but in this one, because of some of the design features, it does have some steel in it. That doesn't affect the energy performance. but it is a question of embodied energy, and some of the detailing becomes harder. You have to work a little bit harder on cold bridging and so on."

An open plan ground floor sits below a five-bedroom first floor, with an orientation toward the garden, affording views intended to make the house a special place to be. The first floor has a reading area, taking advantage of the natural light that fills the space. Back on the ground floor, a utility room complements the open plan kitchen.

For heating, the wood-burning stove is one of three systems that feeds into a 500-litre heat store; there's also a huge (90 tube) solar thermal array and a gas boiler. The heat store feeds underfloor heating pipes downstairs, while upstairs it supplies towel rails in the bathrooms and a duct heater in the supply air of the heat recovery ventilation system.

To some, this might seem like a lot of equipment for a passive house. "I would have been happy with a very minimal heating system," says Luhde-Thompson, "but when I was originally considering a passive house there were very few of them. I could just imagine the complaints I would have had from my family if they had been cold, with no backup heating."

The underfloor heating pipework was cheap to add anyway, he says, and he was keen for a stove for its look and feel in winter. "A normal 6 to 8kW stove would overheat a passive house, so we had to have the heat store to take heat away — and that works perfectly."

The stove does the bulk of the (minimal) heating workload, complimented by the solar, and because he has wood from hedging and trees taken down during siteworks, he's spent almost nothing so far for heating. The gas boiler is a backup but has been little used.

So far, he's barely used the underfloor heating either, except in his wife's study. With a year's experience under his belt, he says they probably could have managed with just having underfloor heating in his wife's office and a duct heater for downstairs, like upstairs.

For Luhde-Thompson, the project was also somewhat serendipitous. While it was on site, project manager Mike Jacob was getting ready to seek funding for Kiss House, a new enterprise that delivers architect-designed, turnkey timber-frame houses built to the passive house standard.

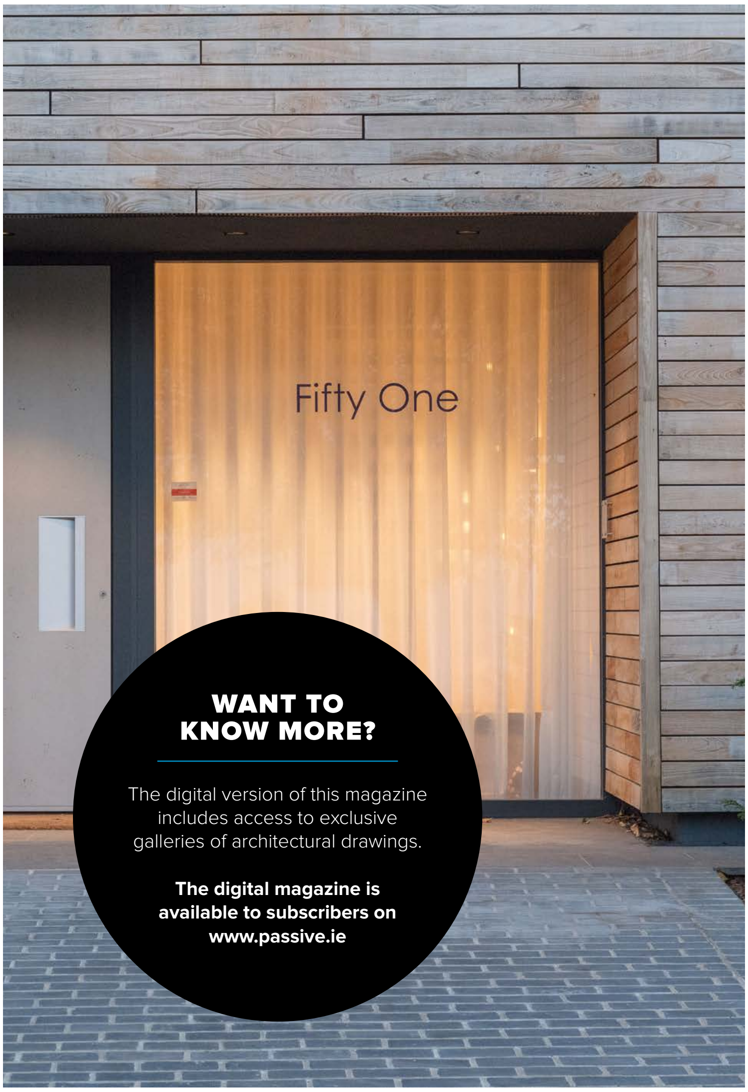
Luhde-Thompson, who was quickly becoming a passive house evangelist, looked over the business plan and ended up becoming one of the primary investors in the new company. "I'm passionate about building more passive houses, and Kiss House seems a great way of achieving that," he says.

And at the Deerings, the end result now is exactly what was planned: a contemporary home, yes, but also one that makes a positive environmental statement, that sets an example for others to follow — one of Luhde-Thompson's motivations for building a passive house in the first place.

As he says: "I also wanted to build one so that other people would be inspired to do so."

"

That's one of the things I like about passive house: you're either getting it or you're not. There's no fudge in the certification.



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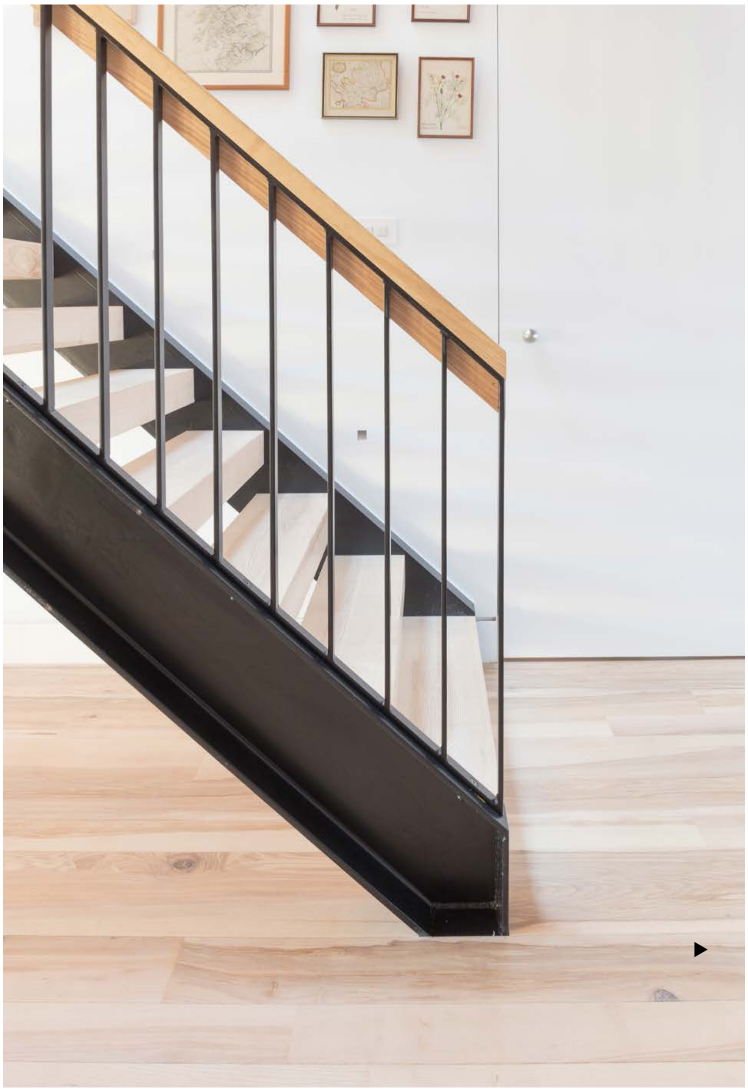
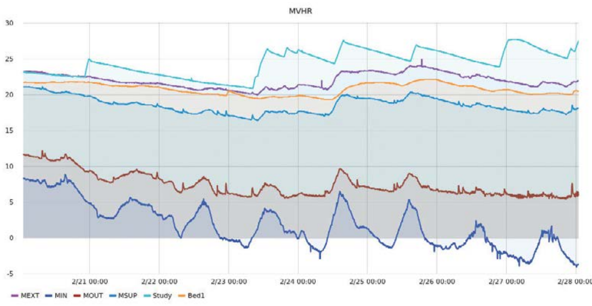
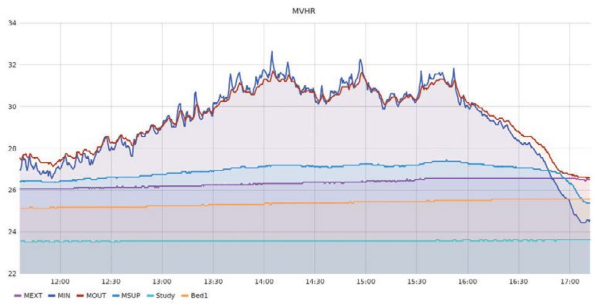


GRAPHING THE DEERINGS

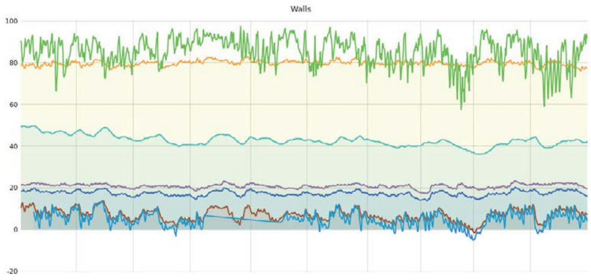
A data obsessive, homeowner Danny Luhde-Thompson has installed 67 one-wire temperature sensors throughout his house, monitoring everything from conditions inside his walls and floor to how hot or cold every element of his heating and ventilation system are. Some of these sensors also record humidity. Here, we present graphs of some of his most interesting data.



(above) Performance of the house during a week of very cold weather between 21 and 28 February 2018. MIN shows the temperature of air being drawn in from outside by the ventilation system (MVHR) — essentially ambient outdoor temperature. MSUP is the temperature of pre-heated warm air the MVHR is supplying to the house. MEXT shows the temperature of air the MVHR is extracting from 'wet' rooms. Bed1 shows the temperature in one bedroom wall, while Study is the temperature in the floor of the study — with spikes when the underfloor heating is turned on. The sensors show consistent, comfortable temperatures during an intense cold spell. MOUT, the red line, shows the temperature of air the MVHR is dumping outside after heating is extracted.



(above) Performance during a remarkably hot summer afternoon, when the temperature of air drawn in by the MVHR (MIN), ie ambient outdoor air, peaked over 32C. MOUT, the temperature of air being dumped outside by the MVHR, tracks this closely, because the heat recovery function is turned off so no heat is being extracted from outgoing air. Temperatures in the study floor (Study) remain below 24C here, but in the bedroom wall (Bed1) they peak slightly over 25C — the passive house definition of overheating. MEXT shows the temperature of air the ventilation system is extracting from wet rooms — again showing signs of some overheating, though temperatures may be warmer in the ventilation duct. MSUP is the temperature of air the MVHR, in bypass mode, is supplying to the house.

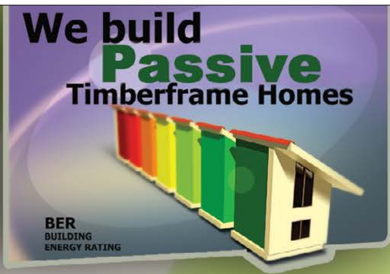


(above) This graph shows temperature and humidity in one external wall between 16 January and 16 March. MIN show the temperature of outdoor air drawn in by the MVHR. WNHO-t is 'wall north high outside temperature', the temperature of an in-wall sensor high on the outside of a north-facing wall, so it closely tracks ambient temperature. WNHI-t is towards the inside of the same wall, with a temperature consistently around or just under 20C. WNHI-h shows humidity on the same sensor, consistently between the 40% and 60% recommended for good indoor air quality. WNHO-h shows humidity towards the outside of this wall, typically around 80%, while OUT-h shows ambient outdoor humidity. Overall the graph reveals a healthy, consistent indoor humidity in spite of humid conditions outside. TB1 is the bedroom temperature, consistently at or just above 20C.

SELECTED PROJECT DETAILS

Client: Danny Luhde-Thompson
Primary architect: Gresford Architects
Passive house consultant: Gresford Architects
Initial architect (planning): Nicholas Tye Architects
Project manager: Mike Jacob
Timber frame manufacturer: MBC Timber Frame
Passive house certifier: WARM Low Energy Building Practice
Structural engineering: Tanner Structural Design Ltd (sub-structure); Peter de Lacy Staunton (super structure); Cubic Building Surveying Ltd (additional structure)
Plumbing & heating: Solinvictus
MVHR design: Williams Energy Design
MVHR supply & install: Touchwood
Electrical contractor: Nightingale Electrical
Window supplier & installer: Ecohaus Internorm
Insulated foundation system: KORE
Blown cellulose insulation: Warmcel, via PYC
Airtightness products: Ecological Building Systems / Partel / Medite Smartply
Solar evacuated tubes: The Small Solar Company
Rainwater harvesting: Rainwater Harvesting
Solar PV inverter: Solinvictus
Wood burning stove: Kamdi24.de
Airtight cat flap: Petwalk
Low VOC paint: Eico
Cladding: Husker Ltd
Drainage: Crofton Design Ltd
Flooring: Sutton Timber
Landscaping: Armstrong Landscapes

MBC TIMBER FRAME



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IN DETAIL

Building type: Detached 5-bedroom timber frame house. Gross internal area 400 sqm.

Location: Harpenden, Hertfordshire

Completion date: October 2017

Budget: Private

Passive house certification: Certified

Space heating demand (PHPP): 12.0 kWh/m²/yr

Heat load (PHPP): 9 W/m²

Primary energy demand (non-renewable, PHPP): 45 kWh/m²/yr

Primary energy renewable demand (PER, PHPP): 37 kWh/m²/yr

Heat loss form factor (PHPP): 2.81
Overheating (PHPP): 2%

Airtightness (at 50 Pascals): 0.51 ACH

Energy performance certificate (EPC): A (97)

Measured energy consumption: In first 12 months, an estimated 2m³ of wood and 82m³ of gas (914kWh) consumed for space & water heating.

Thermal bridging: MBC timber frame system with accredited detail Psi-values; average Psi-value produced by structural steel within superstructure: 0.068 W/mK; chimney Psi-value 0.370 W/mK; stove sporadic operation Psi-value 2.645 W/mK; SVP Psi-value 0.303 W/mK. Total Thermal Bridges account: for 2.7 kWh/m²

Energy bills (measured or estimated): During his first 12 months in the house, Danny Luhde Thompson paid £38 for 82m³ of gas, plus £94 in standing charges. However, from his monitoring he estimates that almost all of this spend was for hot water. He says: "All the [space] heating was really from solar gain, people, four cats and the stove. As well as heating the heat store (6kW), the stove gives some heat (2kW) to the room, and the general ventilation seemed to propagate this around the house nicely." All wood used for the stove was left over from siteworks.

Ground floor: 400mm KORE Floor EPS100 white insulation (EPS300 to perimeter) under 100mm reinforced concrete slab, 4mm concrete screed and 18mm timber floor finish. U-value: 0.092 W/m²K

Walls: 20mm sweet chestnut timber cladding externally, followed inside by 150mm rainscreen cavity formed with timber battens, Solitex Fronta WA monolithic wind tight breather membrane, 12mm Medite vent MDF sheathing panel, 400mm twin timber stud wall formed with 38x89mm studs at 400 c/c fulfilled with Warmcel insulation (thermal conductivity at 0.038 W/m2K), 12.5mm SmartPly ProPassiv board, 45x45mm battens to form service void, 12.5mm Plasterboard, 3mm painted skim. U-value: 0.107 W/m²K

Sarnafil G 410-18EL felt (1.8mm) externally fully bonded to 18mm plywood, followed underneath by 50x50mm ventilated timber battens and timber firrings fixed through to joists, Ampatop Protecta Plus roof membrane, 15mm Smartply OSB, 400mm I-Beam timber joists at 400mm c/c fully insulated with Warmcel insulation (thermal conductivity at 0.038 W/m²K), ProClima Intello Plus vapour control layer, 200x50mm timber battens to form ceiling void, 12.5mm plasterboard, 3mm painted skim. U-value: 0.096 W/m²K

Terrace: 20mm external floor finish, followed underneath by plastic pedestal, Sarnafil protection sheet, Sarnafil G 410-18EL Felt (1.8mm) fully bonded to 18mm plywood, 95x50mm ventilated timber battens and timber firrings fixed through to joists, Solitex Weldano roof membrane, 15mm Smartply OSB, 300mm I-Beam timber joists at 400mm c/c fully insulated with Warmcel insulation (thermal conductivity at 0.038 W/m²K), ProClima Intello Plus vapour control layer, 100x45mm timber battens to form ceiling void, 12.5mm plasterboard, 3mm painted skim. U-value 0.130 W/m²K

Windows, external doors, patio doors: Internorm HF310 passive house certified timber-aluminium window. Average window U-value 0.83 Wm2K. Average g-value 0.45. Internorm HF310 Door, HS330 sliding door and AT410 front door.

Roof window: Lamilux FE Energysave. Passive House Institute certified. Overall U-value: 0.84 W/m²K

Heating system: Rokossa IG2 RLU log boiler stove. 90 tube solar evacuated tube array with Resol differential controller. Worcester Greenstar 24Ri gas boiler (24kW), All supplying 500 litre Energystore Biosolar heat store which in turn supplies underfloor heating, towel rails to upstairs bathrooms, a duct heater in in the supply of fresh air upstairs. Heatstore also supplying domestic hot water

Ventilation: Paul Novus 450 with summer bypass and electric defroster. Lindab ductwork. Roof window motorised, Lindab ductwork. Motorised roof window for extra ventilation.

Water: F Line 7,500 litre tank collecting rainwater used for toilets and garden watering.

External blinds: Roma Quadro 130 S Motorised External blind system. Reduction factor for temporary sun protection at 24%.

Green materials: FSC certified sweet chestnut cladding, ash floor & ceiling, Warmcel cellulose insulation, EICO paints, timber frame structure.

€22
per month
(space heating & hot water)

Building: 249 sqm externally insulated blockwork house

Location: Castlebar, Co Mayo

Completed: April 2016

Standard:
Nearly zero energy building (nZEB)

ELEGANT MAYO

‘LONGHOUSE’ GETS **A1** RATING

The home of a local passive house builder, this super low energy home in County Mayo is inspired by traditional building forms in the west of Ireland — and it blitzed Ireland’s nearly zero energy building standard a whole five years before it was set to become mandatory.

Words by John Cradden

NORTH ELEVATION

SOUTH ELEVATION

The 'longhouse' is one of the oldest and most enduring design templates for one-off dwellings in Europe, but also one of the simplest in terms of its shape, making it a highly suitable form for passive house builds.

Situated in Castlebar, Co Mayo, this modern two-storey take on the longhouse form is being showcased by its owner, local builder Sean Walsh, as a traditional-yet-contemporary nearly zero energy home that adheres to many of the principles of passive house design (while not being certified itself).

The house boasts a superb energy performance coefficient (EPC) of 0.098, smashing the figure of 0.3 that Irish dwellings must meet from 2021 onwards to meet the nearly zero energy building (nZEB) standard. And with its six square metre solar photovoltaic array, the house also achieves a coveted A1 building energy rating.

Design-wise, the finished result is a slight variation on the simpler longhouse form initially proposed by architect Michael Horan of Castlebar-based Axo Architects.

Horan says it was common in the vernacular architecture of the West of Ireland for slightly more affluent folks to build an initial family house of one-and-a-half storeys, and as the family grew, to build on a bit more and then a bit more so that the house became longer and longer but remained the same height and width.

The longhouse shape, as it turns out, is also ideal for adding extra accommodation on a budget, but without complicating the essential shape or layout of the house. "We built the building one room deep, but we stretched the length of the house so it kind of gains a bit of elegance," Horan says.

Walsh says the initial drawings incorporated stone cladding on certain aspects of the house, but he ultimately decided against these on cost grounds.

However, Mayo County Council's planning department then asked for the revised design to be broken up into two volumes of different heights and colour, and with some changes to the window configurations. To some eyes, a 250 square metre house with this footprint, minus the stone, might have looked a bit too plain or too modern but, whatever your view, the final result is hugely appealing for its essential simplicity and elegance.

"You need to keep the design simple," Walsh says regarding building to passive house principles. And he would know. Along with experienced local energy consultant Paul Roberts, Walsh is one half of the partnership behind New Era Homes, a recently established building contractor specialising in passive house builds.

It was the prospect of building this home that prompted the pair to set up New Era Homes. "We were also very conscious of the fact that, as our inaugural build, there were many eyes on us," says Walsh, who also runs ventilation and airtightness specialist S&N Energies together with his brother Noel.

But he is also keen to underline that there is now minimal cost difference between building a house to this standard compared to current Irish building regulations, or to upcoming nZEB standards.

The budget for this build was €300,000 plus VAT — but the final cost ultimately came in at €274,000, though naturally Walsh put in a lot of work himself that wasn't costed. "A regular build, by comparison, would have

> The final result is still hugely appealing for its essential simplicity and elegance.

cost the same," he says.

Working closely with Cathal Brady of energy consultants BEC, the design team devised a specification aimed at keeping the cost versus benefit considerations close to the fore. "We knew that Sean and Paul would be capable of delivering on site," says Horan, who has commissioned Sean to work on several of his firm's other projects.

The build method is a variation on the popular block-on-the-flat system, with 200mm EPS external wall insulation, a Kingspan Aeroground insulated raft foundation, and an insulated pitched-and-slated roof.

"The insulated raft and external insulation were key to achieving close to zero thermal bridging, which is a key passive design component," says Horan.

The windows are triple glazed Rehau Geneo units made from the company's 'Rau-Fipro' material, a combination of uPVC and fibreglass, while also contributing to the impressive EPC score is the Nibe ground source heat pump, Vent-Axia heat recovery ventilation system and a 6 sqm solar PV array.

There were no major challenges or issues reported during construction, although Walsh admits that getting airtightness up to the high standard set for the build was trickier than usual but, as always, attention to detail and discipline within the trades was the key. The finished house scored an excellent airtightness test score of 0.79 ACH @50 Pa, just a fraction short of the passive house target.

Even though New Era Homes pitches itself as a passive house contractor, Walsh made a deliberate decision not to seek certification to save on the cost, though he's happy to offer certification as an option to his clients.

"It's a personal choice," says Walsh. "I

Photography: Michael Horan

CONSTRUCTION IN PROGRESS

1 Installation of the Kingspan Aeroground insulated foundation system; **2** this is followed by a reinforced steel mesh; **3** and a concrete raft poured into the insulation. **4** 200mm EPS external wall insulation being installed; **5** the Atlas Aval external render bring applied; **6** DuPont Tyvek Supro roofing underlay, plus external insulation strip between the low and high roofs; **7** airtightness membrane on ceiling and overlapping onto external walls; **8** airtightness taping around windows; **9** the Nibe ground source heat pump supplies underfloor heating and a 180 litre hot water tank; **10** Paul Roberts and homeowner Sean Walsh, co-founders of main contractors New Era Homes.

> We were also very conscious of the fact that, as our inaugural build, there were many eyes on us.

don't see the necessity to do that.... because I know that the houses that we've built, all of the standards are there. I just don't see the necessity to spend six or seven thousand euro to get someone to rubber-stamp what we can back up anyway. So, it's something that if someone wants it, we'll do it, but no one has asked us to do it to be honest."

This possibly reflects a growing understanding — even a slow mainstreaming — of passive house design principles in this country. While the earliest adopters might have seen the benefit of passive house certification for absolute credibility, perhaps certification will become less coveted as nZEB becomes the norm and fabric-first principles of passive house design start to trickle more and more into the mainstream.

As well as the elegant design of Walsh's home, there are also some nice touches to its orientation, which is bordered to the south and west by a row of trees and a red agricultural shed, creating a garden courtyard.

Horan was also keen to site the house as close as possible to the roadside, as is traditional in the west of Ireland, by placing the east gable perpendicular to the road.

"An awful lot of the modern bungalows now step way back and they have to put up these huge walls in front of the garden and put these big entrance gates and the message is kind of like, 'this is our fortress, don't come in, we don't want any visitors'," says Horan.

But thanks to this clever orientation, the house still manages to be very private, says Walsh — to the point where they felt no need to fit blinds, even to the largest windows. Mercifully, in spite of the lack of shading or overhangs, Walsh reports that the building wasn't uncomfortably hot during this summer's prolonged heatwave – a fact he credits to a combination of window opening for cross ventilation and the buildings externally insulated thermal mass.

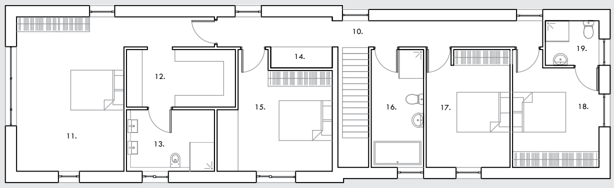
Since moving in, the strongest impressions for Walsh and his family include the outstanding comfort levels and the low-maintenance. "When you arrive in the door after work, on a cold winter's night, the house almost welcomes you in and wraps itself around you. We don't have to consider doing anything from a heating point of view and so we have more quality time to spend with each other doing the things we enjoy."

SELECTED PROJECT DETAILS

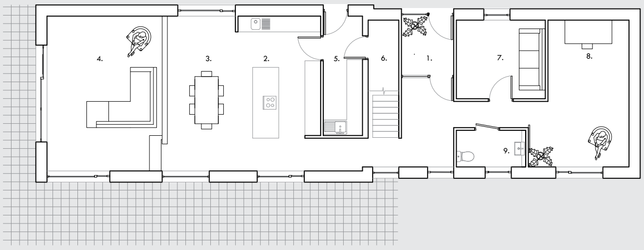
Client: Sean Walsh
Architect: Michael Horan and Seamus Lunn of Axo Architects
Project architect: Aidan Conway
Main contractor: New Era homes
Energy consultant: BEC (Building Energy Consultants)
Electrical contractor: James Heneghan Plumbing & Electrical
Structural engineer: CHH Structural Engineers
Passive raft design: Tanner Structural Design
Passive raft supplier: Kingspan
External wall insulation: Costello Insulation & Construction
Airtightness products: Siga
Insulated plasterboard: Quinn Building Products
Windows & doors: Rehau, via Carrabine Joinery
Heat pump: Unipipe
Heat pump & PV installation: Alex Byrne
MVHR: S&N Energies
Lighting: Flaherty Markets
Sanitaryware: Hurst Heating & Plumbing
Wastewater treatment system: Biocell
Airtightness test: BEC (Building Energy Consultants)
Carpentry & roofing: Canavan Carpentry
Kitchen: Gurteen Kitchens
Screed: Harrington Concrete

> The house boasts a superb energy performance coefficient (EPC) of 0.175, smashing the figure 0.3 that Irish dwellings must meet from 2021 onwards to meet the nZEB standard.

IN DETAIL



FIRST FLOOR PLAN



GROUND FLOOR PLAN

LEGEND:

1. Entrance Lobby.
2. Kitchen.
3. Dining area.
4. Living Room.
5. Utility.
6. Plant Room.
7. Tv Room.
8. Playroom/Study.
9 WC.
10. Landing.
11. Master Bedroom.
12. Wardrobe.
13. Ensuite.
14. Hotpress.
15. Bedtoom 01.
15. Bathroom.
16. Bathroom 02.
17. Bedroom 03.
18. Bedroom 04.
19. Ensuite.

Building type: Detached two-storey house, 249 square metre total floor area, block-on-flat walls with external insulation.

Location:
Derrycoosh, Castlebar, County Mayo.

Completion date: April 2016

Budget: €300,000

Passive house certification:
Not certified or assessed in PHPP

Building Energy Rating: A1 (13.84 kWh/m²/yr)

Energy performance coefficient (EPC):
0.098

Carbon performance coefficient (CPC):
0.092

Airtightness (at 50 Pascals):
0.79 ACH or 0.93 m³/m²/hr

Heat loss form factor: 2.8 (ratio of house volume to total floor area in DEAP)

Measured energy consumption: 3,606 kWh per year (a net figure for all energy use).

Energy bills: The heat pump consumes 1,417 kWh per year for space heating and 445 kWh per year for hot water (the rest of domestic hot water is heated directly by the solar PV). Dividing these equally between day and night rate electricity gives a total estimated annual cost for space heating of €184.17 per year and €80.10 for hot water, not including standing charges or VAT. Divided over the year, this comes to €22.03 per month.

Ground floor: 350mm Kingspan Aeroground insulated foundation system, with concrete raft and insulated screed for underfloor heating. U-value: 0.090 W/m²K.

Walls: Atlas Aval external render on 200mm EPS insulation, on 215mm concrete block-on-flat single leaf construction with 15mm internal render. U-value: 0.13 W/m²K.

Roof: Natural slates externally, on 35x45mm slating battens and counter battens, on DuPont Tyvek Supro underlay, on timber rafters insulated with 300mm Isover Metac roll insulation, on Siga airtightness membrane and tapes, on 50mm uninsulated service cavity, QuinnTherm 50mm insulated plasterboard to underside. U-value: 0.11 W/m²K.

Windows: Rehau Geneo windows using Rau-Fipro material, triple glazed with argon filling and an overall U-value of 0.6 W/m²K.

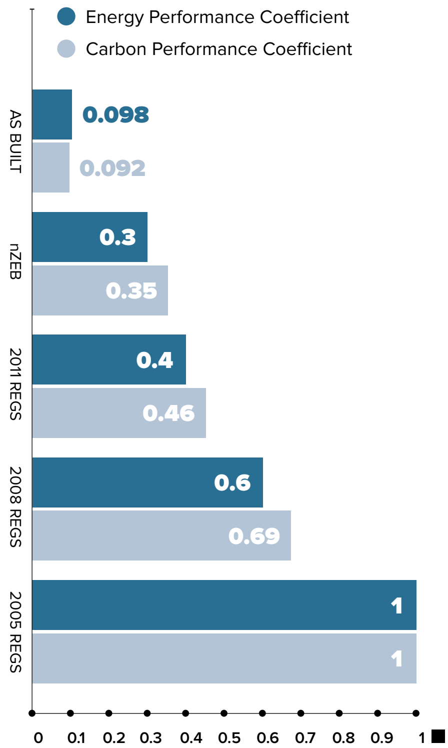
Heating system:
Nibe Fighter 1245 5kW ground source heat pump supplying underfloor heating and 180 litre hot water tank.

Ventilation: Vent-Axia Lo-Carbon Sentinel Kinetic Plus MVHR with EN 308 certified efficiency of 92%.

Electricity: 6m² solar photovoltaic array with average annual output of 2,835 kWh/yr.

Green materials:
Hemihydrate floor screed.

> There is minimal cost difference between building a house to this standard compared to current Irish building regulations.



WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

PASSIVE WEXFORD BUNGALOW WITH A HINT OF THE EXOTIC

Appearances can be deceptive, and with his second A1-rated passive house in County Wexford, architect Zeno Winkens has designed a fairly traditional Irish home that also manages to include some unique design touches.

Words by David W Smith

€10

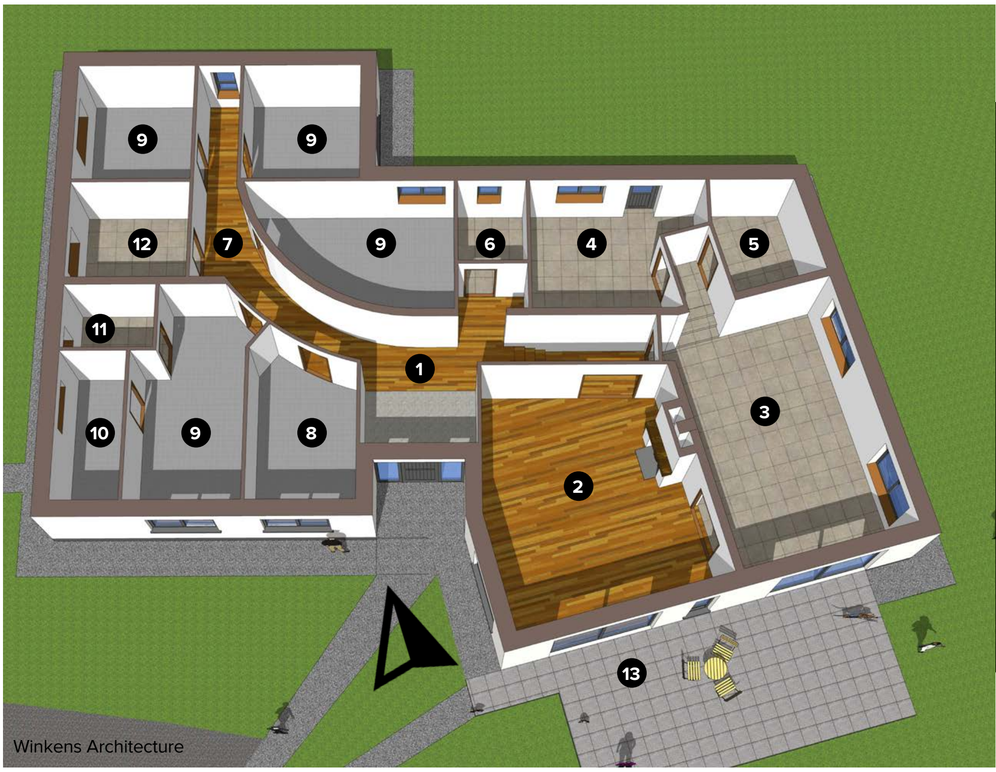
per month
for space heating (estimate)

Building:
227 sqm detached cavity wall passive house

Location: Bunclody, Co Wexford

Completed: January 2016

Standard: Passive house certified



Winkens Architecture

KEY
1 Entrance Hall
2 Sitting Room
3 Kitchen / Diner
4 Utility
5 Pantry
6 WC
7 Bedroom Hall
8 Study
9 Bedroom
10 Walk-In
11 En-Suite
12 Bathroom
13 Terrace

The German-born architect Zeno Winkens brings an exotic range of influences to his designs of houses in rural Ireland. Winkens built the first A1-rated certified passive house in Ireland a few years ago, and has now designed another one, in Drumderry, near Bunclody, County Wexford. Both bungalows blend in with the new builds in their local areas, but also show the influence of California's modernist architects.

It's necessary to go beyond a superficial glance to appreciate the impact of his travels on Winkens's architecture. Born in Bonn, in Germany, he was brought to live in Los Angeles in 1959 at the age of nine months by his architect father, Egon Winkens. Egon was passionate about the work of the great Austrian-born architect Richard Neutra, whose modernist 'Neutra houses' have become iconic in California.

Egon Winkens landed a job with Neutra, and worked his way up to become a partner in his firm during the 1960s. "There are pictures of me as a boy in Neutra houses with Richard Neutra and my dad," says Zeno now.

Egon moved back to Germany in 1968, when Zeno was 10. Then, at the age of 21, in 1979, Zeno was on the move again, this time because his father had decided he wanted to live in rural Ireland. He founded Winkens Architecture, in County Wexford, and Zeno became an apprentice, Sadly, he was forced to take the helm in 1982 after Egon died suddenly of a heart attack at the age of 53.

Both Egon and his hero Richard Neutra are abiding influences on Zeno's work, including this A1-rated passive house in Drumderry, Bunclody. "The main influences are openness and liveability, which were two key features for Neutra. In the Drumderry house the openness is in the open-plan design, and the brightness and airiness of the rooms, all of which have beautiful views through the big glass windows," he said.

"The 'liveability' is about creating a sense of flow and interconnectedness, which is much easier to do in a bungalow like in Drumderry. It's about making sure the utility room is close to the kitchen and there's a separation between reception rooms, where parents entertain, and the bedrooms, so kids can sleep in peace."

Neutra's houses were striking glass-and-steel constructions with huge panes of glass. Because he was building in the Californian desert, there were big overhangs for shading. Zeno's designs have large areas of glazing to let the light in, too, but in contrast to Neutra he prefers solid rather than glazed corners. Although the influences are exotic, the look of the bungalow fits rural Ireland.

Owner Enda Slevin says: "You could say it's more spectacular inside than outside. Even though Zeno has designed a lovely curved wall and the layout is fantastic, the exterior looks like your average Irish country new build. But that's what we wanted. We didn't want it to stand out."

Slevin is a local man who returned to Wexford with his partner Deirdre Dunne and their young baby in 2010. They rented three different properties initially but could not find the comfort they craved. The last rental property was so poorly insulated that

> The main influences are openness and liveability, which were two key features for Neutra.

> We get lovely sun in the mornings and great light for most of the day.

they spent weeks in winter with cold hands and feet. In researching energy efficient housing, Slevin stumbled upon the passive house concept. Google led him to Zeno Winkens, who had designed the first A1 passive house in Ireland just a few miles away, near Bunclody.

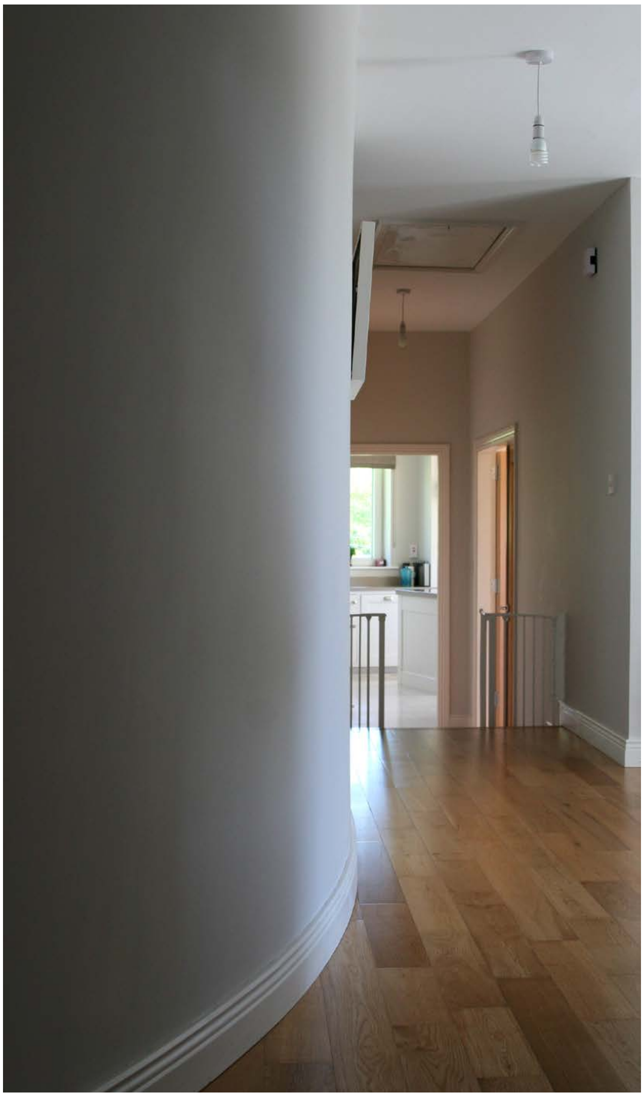
Slevin visited the first Bunclody passive house and spoke with the owner, Francis Clauson. Enda decided it was everything he wanted and employed Zeno to design it. There was one big difference in the process compared to Zeno's first passive house. Francis Clauson obsessed over every detail of the house, and presented Zeno with a highly detailed brief, "nearly down to the hooks on the back of the door in the children's bedroom."

Enda was more laid back. He had only three stipulations. He wanted a standard bungalow; it had to achieve passive house status; and it had to have an open plan living area. Other than that, he left it to Zeno to come up with a design. Although similar to the first house, there were important differences. Francis Clauson's house was significantly larger and had three en suite bathrooms. Enda's 227 sqm bungalow had just one en suite out of its four bedrooms.

Slevin's site was also on top of a hill, which allowed Zeno to add certain design features. "The slope allowed us to make the living room and the kitchen-diner three steps lower than the rest of the house. We could also lower the ceiling in the living room area," he says.

The design was straightforward, but Winkens had initial concerns about whether the builder could deliver a passive house. He used a local tradesman, Sean O'Brien, on Enda's wishes, but O'Brien had never worked on a passive house before. He need not have worried. In the end, Zeno had nothing but praise for O'Brien's work, which delivered a passive-standard airtightness rating of 0.57 ACH.

A large rooftop solar PV array, meanwhile, provides electricity for hot water. A Brink heat recovery ventilation system supplies



Photography: Winkens Architecture

fresh air to the living rooms and extractions from all wet rooms, while the main source of heat is a Nibe air-to-water heat pump supplying underfloor heating.

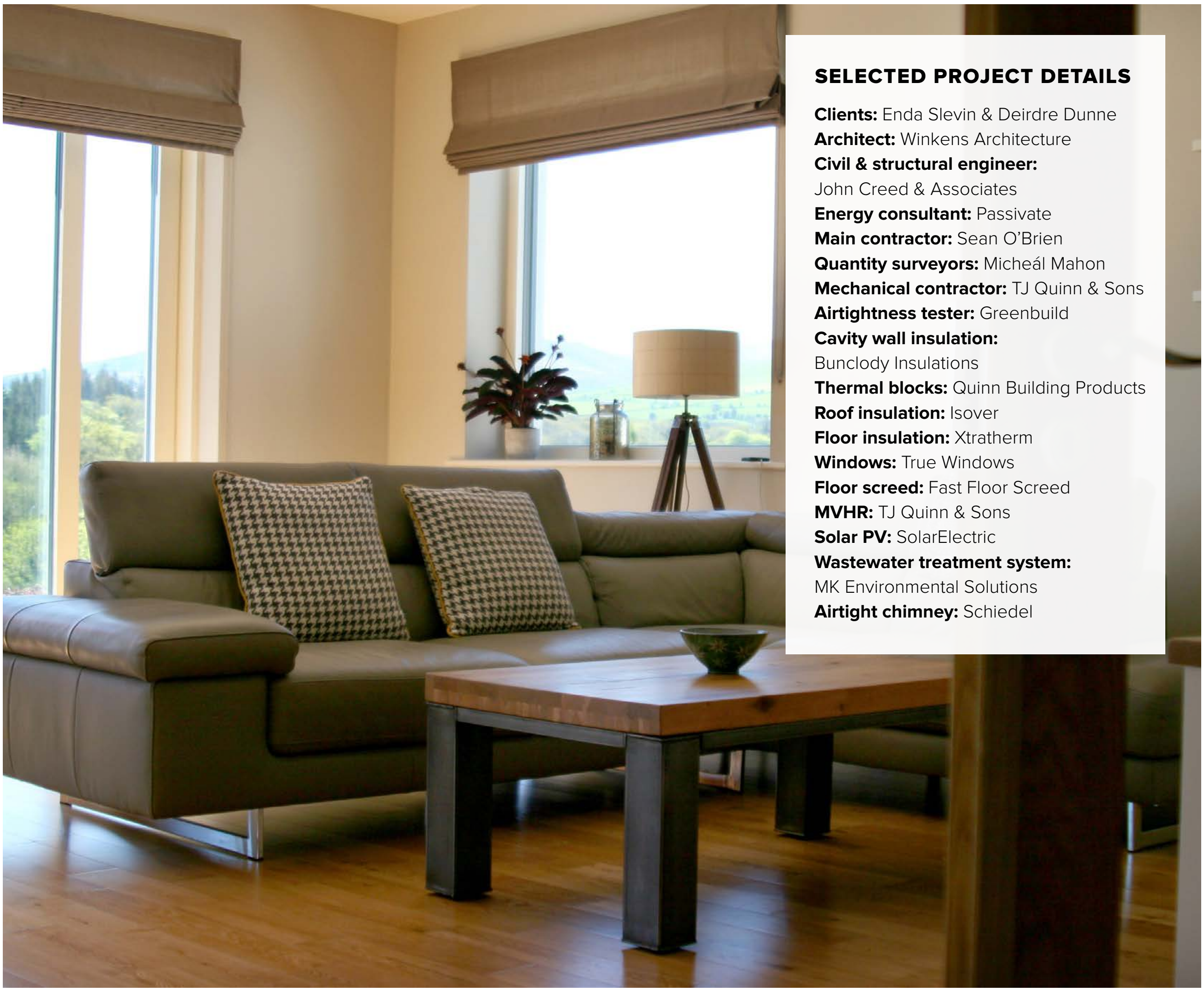
The construction of the house took a year during 2015 and Enda moved in with his partner, Deirdre and young child, in January 2016. Since then, the pair have had a second baby and are settled happily in the house, which is opposite the home of Enda's parents. The costly struggles to heat their draughty old Irish rental houses have come to an end.

The overall cost of the house was 10-20% more than a standard build, but we intend this to be our home for life and we'll recoup the costs over several years in energy savings. Our electric bills are much lower than in the rental properties, even though we run everything off the electric heating. It's a good long-term investment as the price of oil is only going to rise," says Enda. "We also love the house because the living room and kitchen face dead on south, so we get lovely sun in the mornings and great light for most of the day."

> He wanted a standard bungalow; it had to achieve passive house status; and it had to have an open plan living area.

CONSTRUCTION IN PROGRESS

1 The strip foundation featuring radon barrier for airtightness; **2** the walls have a 250mm wide cavity which are fully insulated with expanded polystyrene (bonded bead) insulation; **3** XPS insulation at door threshold; **4** above the concrete floor slab is 300mm of EPS100 rigid insulation with a PIR insulation strip around the perimeter; **5** airtightness detailing around windows; **6** construction of the timber roof trusses underway; **7** Strip of Xtratherm PIR insulation used at wall plate level; **8** airtightness membrane fixed to underside of roof trusses below insulation layer, with suspended service cavity below; **9** Gavin Ó Sé of Greenbuild carries out smoke testing during an airtightness test to check for air leakages in the building.



SELECTED PROJECT DETAILS

Clients: Enda Slevin & Deirdre Dunne
Architect: Winkens Architecture
Civil & structural engineer: John Creed & Associates
Energy consultant: Passivate
Main contractor: Sean O'Brien
Quantity surveyors: Micheál Mahon
Mechanical contractor: TJ Quinn & Sons
Airtightness tester: Greenbuild
Cavity wall insulation: Bunclody Insulations
Thermal blocks: Quinn Building Products
Roof insulation: Isover
Floor insulation: Xtratherm
Windows: True Windows
Floor screed: Fast Floor Screed
MVHR: TJ Quinn & Sons
Solar PV: SolarElectric
Wastewater treatment system: MK Environmental Solutions
Airtight chimney: Schiedel

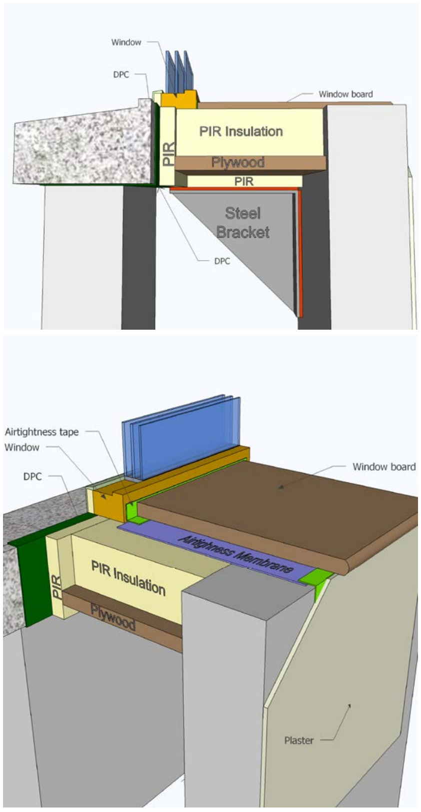
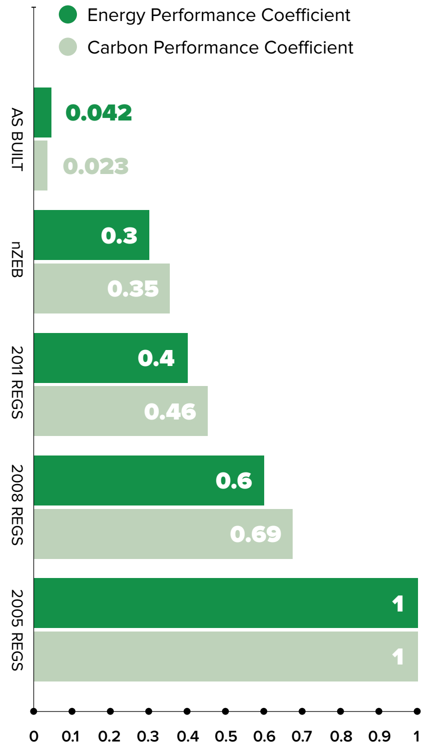


Image: Winkens Architecture


Energy Performance Coefficient
Carbon Performance Coefficient
AS BUILT
0.042
0.023
nZEB
0.3
0.35
2011 REGS
0.4
0.46
2008 REGS
0.6
0.69
2005 REGS
1
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

IN DETAIL

Building type: Detached 227 sqm bungalow with wide cavity construction.

Location: Drumderry, Bunclody, Co. Wexford

Completion date: January 2016

Budget: Private

Passive house certification: Certified

Space heating demand (PHPP): 16 kWh/m^2/yr

Heat load (PHPP): 10 W/m

Primary energy demand (PHPP): 40 kWh/m^2/yr

Heat loss form factor (PHPP): 3.81

Overheating (PHPP): 0% of year above 25C

Energy performance coefficient (EPC): 0.042

Carbon performance coefficient (CPC): 0.023

BER: A1 (6.73 kWh/m^2/yr)

Measured energy consumption: Not known

Airtightness: 0.57 ACH at 50 Pa or 0.61m^3/m^2/hr at 50 Pa

Thermal bridging: Mix of Irish ACDs, Quinn Lite certified details and bespoke details. First two courses of Quinn Lite blocks to inner leaf, low thermal conductivity Teplo cavity wall ties. Calculated Y-factor (W/m^{2}K): 0.019

Energy bills (estimated): Calculated pace heating demand for the whole house is 3,632 kWh/yr in PHPP. Considering its seasonal efficiency of 410%, the Nibe F2040 heat pump consumes 886 kWh per year to generate this amount of heat. Dividing this evenly between typical day rate (18c) and night rate (9c) electricity yields an annual estimated bill for space heating, including VAT but not standing charges, of €119.60.

Ground floor: Strip foundation, concrete floor slab insulated above with 300mm rigid insulation EPS100 and PIR strip around perimeter. 65mm Sudanit 280 fast screed above EPS with underfloor heating pipes embedded. Radon barrier under slab for airtightness taped to internal plaster layer on walls. U-value: 0.107 W/m^{2}K

Walls: Fully insulated blockwork cavity wall, with expanded polystyrene (bonded bead) injected into 250mm wide cavity. Internal plaster forming airtight layer. U-value: 0.129 W/m^{2}K

Roof: Slated, timber roof trussed construction insulated with 420mm Isover Heatshield & Isover mineral wool insulation. Airtightness membrane fixed to underside of roof trusses below insulation layer, with suspended service cavity below. U-value: 0.084 W/m^{2}K

Windows: Gutmann AG MIRA therm 08 timber windows with external aluminium shell. Passive House Institute certified. U-value: 0.87 W/m^{2}K. Glazing: Saint-Gobain Climatop Lux glass, triple glazing of 52mm. Warm edge spacer swisspacer. Ug-value: 0.6 W/m^{2}K, g-value: 62%

Heating system: Air-to-water Nibe F2040 heat pump distributing to underfloor heating system. Hot water: direct electric water heater from PV panels with air-to-water heat pump contribution. Room sealed stove connected to a Schiedel chimney system.

Ventilation: Brink Climate Systems BV Renovent Excellent 300 (Plus) heat recovery ventilation system supplying fresh air to all living rooms and extracting from all wet rooms. Effective heat recovery efficiency of 84% (passive house certified).

Electricity: 24.4 sqm solar PV array. 15 panels installed on the roof with an electricity yield of the inverter of approx. 3,678 kWh/yr. ■

RUNNING AMOC

HOW THE POTENTIAL SHUTDOWN OF OCEAN CURRENTS, FUELLED BY MELTING ICE CAPS, COULD DRAMATICALLY CHANGE OUR CLIMATE

Words by John Gibbons

If you look at Ireland on an atlas, one thing that is striking is just how far north the island is located. Follow the lines of latitude east across the Atlantic and we are parallel with the Labrador peninsula in northern Newfoundland. This bleak, chilly landscape, where average winter temperatures rarely rise above zero degrees Celsius was famously portrayed in The Shipping News, a novel by Annie Proulx.

Ireland's coldest month, in contrast, is January, with average temperatures of 5C; relative to Newfoundland, this is positively balmy. The difference between Ireland and Newfoundland is the Atlantic Meridional Overturning Circulation, or AMOC. This is just one part of a complex global system of ocean currents that act like a conveyor belt for currents. The AMOC transfers vast amounts of heat from the Caribbean region and brings this warmth to north western Europe.

One obvious beneficiary of this bounty is Garnish island in Bantry Bay. It enjoys an almost sub-tropical climate, as the warm surface waters drawn from the equator lap its shores, allowing it to support exotic plant species that would not survive elsewhere in Ireland.

Earlier this year, two research papers[1] published in the respected journal Nature reached the same disturbing conclusion: the AMOC has slowed down by some 15% in recent decades, and the trend appears to be accelerating. The impacts of global warming, including the rapid melting of hundreds of billions of tons of freshwater from the Greenland ice sheets, is disrupting this vast current.

The idea of the AMOC (also known as the Gulf Stream) closing down suddenly was dramatised in the 2004 film, The Day After Tomorrow, which imagined a shutdown of the ocean currents triggering a series of epic superstorms which then plunged the northern hemisphere into a new ice age.

While scientists scoffed at the liberties Hollywood took with science, the basic premise that the AMOC could shut down in a relatively short time frame, such as by the end of the century, and that this in turn would have catastrophic consequences for the entire north Atlantic region is entirely plausible.

Just how severe these impacts might be was explored in depth by Nasa's former chief scientist, Dr James Hansen, and his colleagues in a 2016 paper[2]. "If Greenland fresh water shuts down deep water formation and cools the North Atlantic several degrees, the increased horizontal temperature gradient will drive superstorms, stronger than any in modern times," Hansen explained in a video explaining his research[3]. "All hell will break loose in the North Atlantic and neighbouring lands."

Hansen's research team identified a previous period of rapid global warming around 120,000 years ago, towards the end of the Eemian period. At that time, a collapse of polar ice, fast rising sea level and a shutdown of the AMOC led to superstorms of epic dimensions sweeping the region.

A number of rocks, weighing up to 1,000 tons each, have been located perched on a cliff 20 metres above the Atlantic on an island in the Bahamas. Hansen believes these giant boulders were scooped up from the sea floor and tossed inland during a period of megastorms much bigger than anything modern humans have ever endured.

The AMOC shutdown would lead to the temperature difference between the newly chilled northern hemisphere and the even hotter tropics increasing sharply, and this temperature difference would be the fuel for catastrophic megastorms. Storms notwithstanding, the AMOC shutdown would likely cause land temperatures in Ireland to plummet by several degrees, effectively wiping out our agricultural sector.

And while climate change almost never receives serious or sustained media coverage in Ireland, the recent confluence of extreme weather events has left many people

Photo: Myirelandtour.com

Photo: chesapeakeclimate

(facing page) Cork City during February's 'Beast from the East' snowstorms; (above left) Storm Ophelia, the easternmost Atlantic major hurricane on record, moving over Ireland and the UK last winter; James Hansen, former chief scientist at Nasa and one of the world's most renowned climate experts.

wondering aloud if this is a bitter foretaste of what the scientists have been warning about for decades. The summer of 2018 has seen Ireland bask in an extraordinary sustained heatwave, triggering the worst drought in almost a century.

As recently as March 2018, Storm Emma swept in a severe snow event. A few months earlier, in October 2017, the tail end of Hurricane Ophelia battered Ireland, leaving three dead and a swathe of destruction across the country. A hurricane has never before been recorded in this part of the north Atlantic. And just two months earlier, a so-called 'once-in-a-century' monster flooding event in August 2017 centred in Donegal triggered landslides, with bridges and roads swept away in the deluge.

Commenting on the Donegal downpour, UCC climatologist, Dr Kieran Hickey suggested to me[4] that: "phrases like 'once-in-a-hundred years' to describe these extreme events really need to be retired". Over the last decade or so, he estimates that Ireland has experienced an extreme weather event, on average, every six to 8 months. This represents a staggering four to five-fold increase in the frequency of such extreme events versus typical Irish weather in the 20th century.

While there is little doubt the deluge in Donegal was a freak weather event, "if we were to do an in-depth analysis, I suspect we would detect a climate change element in terms of its severity," added Dr Hickey.

An EPA-funded climate attribution project involving Dr Hickey and colleagues at UCC, as well as Prof Myles Allen of Oxford University will spend the next two years investigating the specific fingerprint of climate change on recent extreme weather events in Ireland. This may help to answer that seemingly eternal question as to whether and to what degree any specific extreme weather event may be influenced by climate change.

While it is standard practice among weather forecasters to be reluctant to attribute any single event to climate change (given the huge natural variability within the climate system), climate researchers have been able to establish with a high degree of confidence that man-made climate change dramatically increased the likelihood of the extreme heatwave that swept much of Europe during June 2017[5].

The researchers who carried out this work are known as World Weather Attribution (WAA), an international coalition of scientists who examine and try to quantify the role of climate change in individual extreme weather events.

The extreme temperatures that scorched the European mainland (but missed Ireland) last summer, and that left Ireland sweltering this year, will become commonplace by mid-century "unless action is taken to rapidly cut carbon emissions", the WAA stated.

"Since 1900 we have seen the likelihood of a summer as hot as 1995 increase 50-fold", NUI Maynooth climatologist, Dr Conor Murphy, wrote in the Irish Times[6]. "By the end of the century our warmest summer on record up to now could plausibly by then be a cool summer," he added.

The pattern of extreme weather that has rocked Ireland and many other parts of the world in just the last year fits eerily well into the more pessimistic modelling scenarios of climate specialists, who warn of the impact of 'supercharging' the global climate by pumping more and more CO_2, along with other greenhouse gases such as methane, into the global atmosphere.

Rigorous instrumental measurement of atmospheric CO_2 only began as recently as 1958, but we have accurate records stretching back some 800,000 years. In 1958, thanks to the pioneering measuring work of Dr Charles Keeling, we know that global atmospheric CO_2 levels stood at 316 parts per million (ppm). Since then, CO_2 has increased by almost 40% to today's level of around 410ppm.

In other words, we have in just the last 60 years drastically altered the basic chemistry of the global atmosphere. Today's CO_2 levels are likely the highest experienced on Earth for at least three to five million years. Since the end of the last ice age some 12,000 years ago, humans have flourished, our numbers expanded exponentially and our impacts are now being felt in every corner of the biosphere, from the upper atmosphere to the ocean basins.

The current interglacial era, known as the Holocene, has been perfect for humans, gifting us a prolonged period of thousands of years of, by historical standards, stable, benign climate, which has made global agriculture possible. But many earth scientists now say that the Holocene is over and that we are in a new geological era, the Anthropocene — the Era of Man.

We have known for decades that loading vast amounts of CO_2 into the global atmosphere would lead to a sharp increase in global average temperatures. Already, the world has warmed by over 1C since pre-industrial times. Worse, this heating will spike by 2C, 3C, 4C, or even more this century if carbon emissions and land uses changes such as deforestation continue unabated.

This may not at first sound catastrophic, but it represents the most rapid rate of change in atmospheric conditions on Earth since a large asteroid slammed into the Yucatán peninsula in Mexico some 66 million years ago, triggering the global cooling event that led to the extinction of the dinosaurs.

In 2012, the World Bank commissioned a report to better understand what a world 4C hotter than today might look like. Its president, Jim Yong Kim described this level of temperature increase as a "doomsday scenario" that would trigger widespread crop failures and malnutrition and dislocate tens of millions of people from land inundated by rising seas and regions of the Earth, such as much of the Middle East, that become too hot for human habitation or agriculture.

Consider the political impacts on Europe of hundreds of thousands of refugees fleeing failed states in Africa and the Middle East in recent years. Multiply these numbers by 100 or even 1,000 and you begin to grasp the existential nature of the climate crisis.

If the status quo continues, Ireland's island status will offer only the briefest of respites from the wrenching climate-fuelled upheavals that will drastically reshape our world in the coming decades.

1. Atlantic overturning during the past 150 years Nature 556, pages 227–230 (2018) & Observed fingerprint of a weakening Atlantic Ocean overturning circulation, Nature 556, pages191–196 (2018) **2.** Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2C global warming could be dangerous, Atmospheric Chemistry and Phyiscs, 3761–3812, 2016 **3.** www.youtube.com/watch?v=KLk8Uy2-Lsk **4.** 'Climate change is happening right now', Irish Times, September 1 2017 **5.** https://www.worldweatherattribution.org/euro-mediterranean-heat-summer-2017/ **6.** Irish heatwave reveals vulnerabilities we should not ignore, Irish Times, July 7 2018

FUTURE PROOF

DESIGNING BUILDINGS THAT WITHSTAND CLIMATE CHANGE

Over the past year cold snaps, heat waves and severe storms have all brought the reality of the climate crisis home to the UK and Ireland. But with the climate changing in fast and uncertain ways, how can we construct buildings that will remain resilient — and keep their occupants healthy and comfortable — long into the future?

Words by Kate de Selincourt

The climate is changing – this much we know. The weather our buildings are supposed to protect us from is changing too. But how many of these changes can we anticipate, and how effectively can we respond?

There are two sorts of change that we need to anticipate. First are the changes that are predicted by expert agencies such as the Intergovernmental Panel on Climate Change and the UK's Met Office. These can be fed into building performance models to give us a pretty good sense of how a building will perform if these predictions turn out to be correct.

And then there are the 'wild card' changes. Extreme weather events are expected to become more common as the climate changes – so more storms, floods, droughts and heatwaves. One of the wildest of wild cards is the potential of a rapid slow-down in the Atlantic meridional overturning circulation (AMOC) leaving the UK and Ireland with a much colder climate, as discussed by John Gibbons elsewhere in this issue.

Then there is the speculative nature of the science of prediction itself – all the climate models can offer us is probability-based scenarios, and these are based on assumptions of how much we manage to reduce carbon emissions, and by when. Which is something of an unknown, to say the least.

Some projected changes are easier to understand because they are happening already. Summer temperatures are expected to rise, with high night-time temperatures a particular issue for people in cities dominated by hard surfaces. After the scorching summer of 2018, this reality is starting to hit home.

Other changes that we are already experiencing include more intense rainfall events, and more storms – even hurricanes (Ophelia, which battered the UK and Ireland last winter, started life as a tropical hurricane). At the time of writing the tail end of Hurricane Helene was expected to arrive on these shores.

If AMOC were to slow down significantly, the UK and Ireland would very likely have a much colder climate, similar to that of other regions at a similar latitude (think Newfoundland or the Baltic). But the prospect of more icy winter blasts at least makes it clear that designing for the future climate by using less insulation isn't going to cut it.

Even without northwest Europe descending into an Iceland-like climate, winter is still going to be the cause of a great deal of thermal discomfort and ill health in future (cold homes and fuel poverty are serious winter issues in Greece, Spain and many other 'hot' countries, with poorly insulated buildings a likely cause).

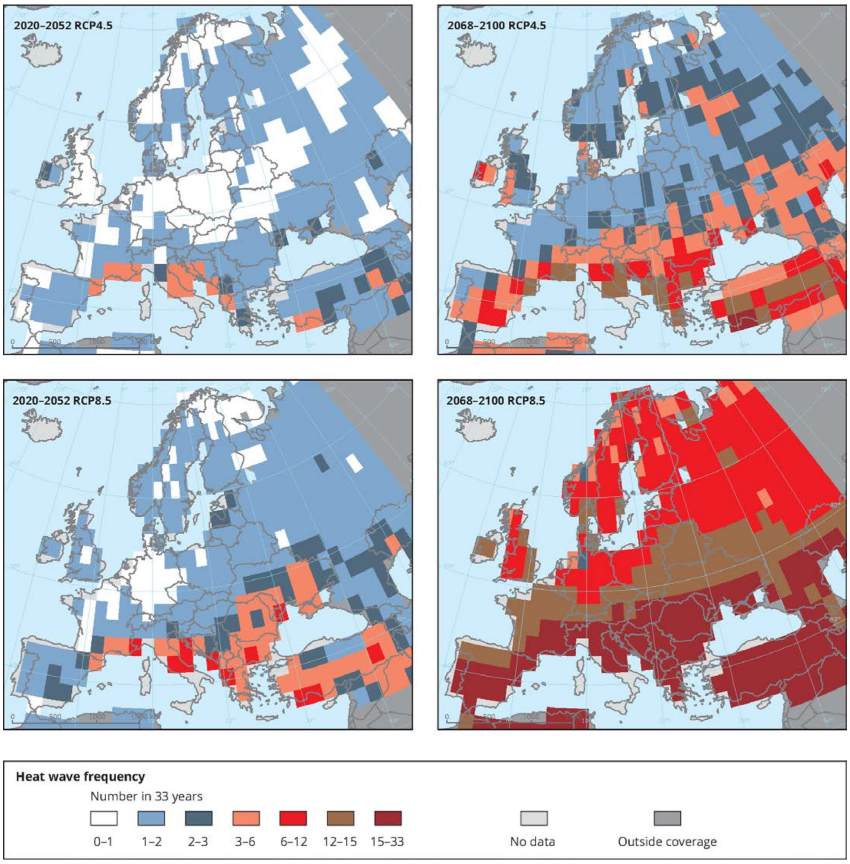
And as the UK Committee on Climate Change pointed out in their 2017 risk assessment report, although the number of heat-related deaths in the UK is projected to increase as the climate changes, the numbers of cold-related deaths is still expected to remain much larger.

Designing for the future

Given that UK building regulations have not even caught up with designing for the present climate, perhaps it's not surprising that they don't require designers to prepare for the future either. The UK's national building energy assessment tool, SAP, does not require

> Cold homes and fuel poverty are serious winter issues in Greece, Spain and many other 'hot' countries.

Photo: Erik Drost



(above) Number of projected extreme heat waves under two difference climate change scenarios. Under RCP4.5, emissions peak around 2040 and then decline. Under RCP8.5, emissions continue to rise throughout the 21st century. Graph: European Environment Agency

> The UK is “woefully unprepared” for deadly heatwaves.

overheating to be assessed. But things are beginning to change at local level. The new London Plan requires major developments to demonstrate how they will reduce the potential for overheating and reduce reliance on air conditioning. And Exeter City Council is not only commissioning new buildings to the passive house standard, but it also requires designs to be resilient to projected conditions in 2030, 2050 and 2080 (See ‘How Exeter is building for the future’). The UK’s new national planning policy framework also advices local authority planning departments to prepare for climate change. Ireland is also starting to address the issue. A new version of Part L for new dwellings, which went out to consultation this spring, requires “that the building is appropriately designed to avoid the need for cooling,” with guidance to be provided in Ireland’s national methodology, DEAP, for calculating an overheating risk assessment.

Heat

If, as expected, climate change makes our summers hotter as this century progresses, overheating in buildings is likely to become an increasingly serious cause of ill health and even mortality. Early analysis of 2018’s weather is already suggesting that there were between 600 and 1,000 extra deaths in the UK in this summer’s hottest fortnight alone, and older persons with heart or kidney problems were most vulnerable.

The UK is “woefully unprepared” for deadly heatwaves, according to a House of Commons environmental audit committee report in July 2018. The committee’s MPs said the government had ignored warnings from the Committee on Climate Change, its official climate change adviser, and that without action heat-related deaths[1] will triple to 7,000 a year by the 2040s.

As well as the familiar issues with overheating – such as cardiovascular stress, particularly in elderly occupants — there is also the possibility of worsening air quality as volatile compounds from building materials, finishes and furnishings become more mobilised to the air.

This is not a well-studied area, but elevated levels of formaldehyde, and other potentially toxic organic compounds have been reported in the air of buildings reaching temperatures only 7C or so above normal operative temperatures – not at all uncommon in overheated buildings[2].

But while there is a common misconception that low energy houses will be hotter in summer, in reality insulation and airtightness are also valuable tools for keeping them cool and comfortable during hot weather. As Jill Dawson, the wife of passive house designer Meredith Bowles, tweeted during the summer heatwave:

‘Your house is nice & cool - do you have aircon?’ asks Tesco delivery man. Not a fan or aircon anywhere. Just solar shading, good ventilation & brilliant design (it is a passive house)…Why aren’t all new houses in UK designed well? And no, it wasn’t costly.

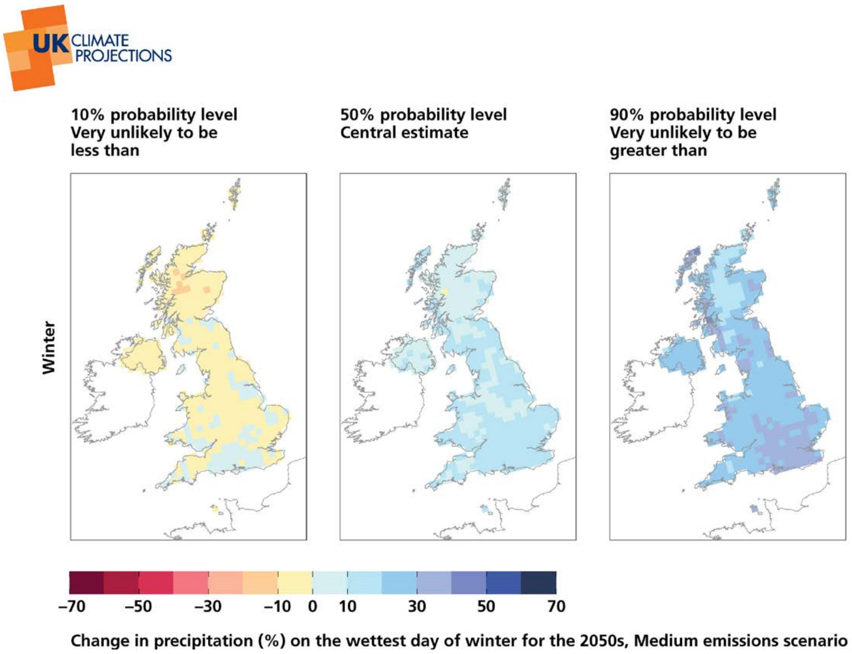
Because passive houses have heat recovery ventilation, which recovers heat from outgoing stale air and uses it to pre-heat incoming fresh air, they can be kept more comfortable than ‘regular’ dwellings: use heat recovery when it’s colder outside than inside; turn heat recovery off if it starts getting too warm indoors. And when it’s hotter outside than in, you can turn the heat recovery back on. This will keep heat out by returning it to outgoing air before it comes into the house (you could call this “cool recovery”) — meaning you can keep a passive house cooler than a normal building on very hot days.

However, most UK buildings fail to deliver this kind of comfort. And as passive house consultant Nick Grant complains, too many building designers still fail to take summer comfort seriously. Solar and internal gains are still the big issue, he says.

Caroline Martin of passive house design and certification firm Warm agrees. “Excessive glazing and full height glazing are easily identifiable flags for concern,” she says.

There are other common pitfalls too. “Our monitoring data shows that cross ventilation also makes a really big difference. So single aspect small flats are at high risk of overheating... High occupancy, or occupants that are home all day in a small dwelling, are also a flag.”

But what about our existing, non-passive house buildings? Can we hope to protect their occupants from escalating hot weather? The good news is, many of our overheating



(above) Graph: UK Climate Projections 2009

buildings can, at least under current conditions, be made a lot more comfortable just by enabling the ventilation that is theoretically there.

Highly-glazed and poorly ventilated existing buildings are likely to be the first to require retrofitted solar shading in future. This will not always be easy of course (particularly with tall buildings, where the more low-tech solution of external blinds probably won't withstand the wind). But for all existing buildings, a simple but very effective measure will be to improve the provision of secure ventilation – in particular, at night. In some cases, a measure as simple as secure window closers allowing a window to be safely left ajar would make a huge difference.

There have been repeated calls in the UK and Ireland for modelling of overheating to be made mandatory for building designers. With rising temperatures, simply testing designs against current summer conditions isn't enough.

The Chartered Institution of Building Services Engineers, CIBSE, has developed climate files, based on the UK Met Office's 2009 set of climate forecasts, that can be used in building models to test designs against hypothetical future scenarios. The Met Office is set to publish a fresh set of projections later this year, and CIBSE research manager Dr Anastasia Mylona says the group will then model how these new projections are likely to affect building performance.

An air-conditioned future?

At the moment, it is pretty much an accepted view among designers of sustainable buildings, that to install energy-hogging air conditioning is to admit a building has failed. This is a reasonable view while average outside temperatures are lower than comfortable indoor temperatures. But the principle doesn't hold when outdoor temperatures rise so much that there is insufficient cool air available to remove unwanted heat from buildings.

While the human body can adapt, to a small extent, to rising temperatures, the adaptive thermal comfort models – based on observation – accept that as temperatures rise, tolerance rises more slowly and is eventually overtaken: it's too hot. At which point, given that we accept that it is legitimate to heat a cold space, does it not also become acceptable to cool a hot one?

Rain

Climate change is expected to increase the intensity and frequency of severe rainfall events, and Dublin-based architect and building moisture expert Joseph Little thinks we should be taking this possibility seriously in how we design and retrofit buildings now.

"Arguably we need to be building predominantly pitched roofs with wide overhangs and deep box gutters on commercial buildings as well as domestic," he says.

"It begs the question as to why you would have any parapets or inner valleys on any buildings, unless those parapets are fully tanked to 300mm or more with commensurate hoppers, downpipes, drains and significant attenuation measures such as green roofs."

Architect Andrew Yeats runs the practice Eco Arc in the notoriously wet north-west of England, and many of his clients also occupy elevated sites. "Our rain mainly comes in horizontally," he says.

"If clients ask for a flat roof I just say no. For an exposed location I insist on a steeply pitched roof, big overhangs and big gutters, and I won't have anything to do with balconies or parapets.

"I always insist on a ventilated cavity over a timber frame, so any rain that gets though can just run down the back of the rainscreen without touching the main structure.

"I'm queried about this by timber framers, may often offer a system with a board that can be fixed to the frame and rendered. But boards are likely to move, if only infinitesimally — but once you have a crack of any kind, the driving rain will find its way in, leading to more movement, and more water penetration.... it's a disaster waiting to happen.

He continues: "We do build in solid masonry too, but I'm only comfortable with a full-filled cavity if the outer skin is concrete block with a silicone render – not lime-jointed brick or stone, as I know the driving rain will push in through the cracks. I know there are specialist cavity insulants that are supposed to perform well even when there is a risk of rain reaching the cavity, but I'm not comfortable with the idea."

Yeats believes tremendous care is needed when retrofitting energy efficiency measures to a traditional building that faces – as most buildings will, sooner or later — extreme rain events.

"For retrofit we much prefer to use external wall insulation. We tend to use a rendered EPS [expanded polystyrene] system." EPS is more vapour open than polyurethane foams, but the theory is that it is not damaged by rain if it should get in.

Indeed, retrofit of insulation in the UK and Ireland is already failing in regard to moisture (as seen in the disastrous retrofits in Fishwick, Preston, reported in Passive House Plus issue 24). An increase in driving rain and extreme rainfall events is only going to make the situation worse.

Joseph Little believes the common "budget" detail for external wall insulation, used at Preston — in which roof eaves are not extended to make room for more insulation underneath, but instead insulation is stopped short of the roof — should be banned. "If the roof can't be extended and the wall protected, the works should not be done," he says.

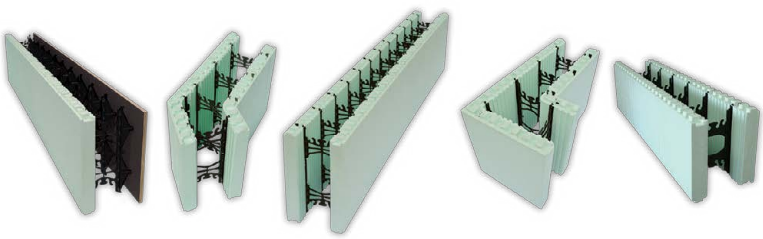
He also shares the concerns of many about retrofitting cavity insulation where driving rain is now, or promises to become, a risk. "Arguably we shouldn't be filling any narrow cavities in external walls," he says, meaning cavities less than 75mm wide. He says many wall cavities have been insulated with fibre and bead in contravention of the BRE's "compelling cautious guidance" in the BR262 document on avoiding risks with insulation.

Little believes that warmer, wetter weather will stress wall build-ups more, and that in future cavity insulation may only be used for new-build wide-cavity rendered walls, and for renovation in areas with low exposure to rain. "I suspect there will be a very active industry removing insulation fill in the years to come," he says.

He also warns that — with the number of





(above) Andy Simmonds, CEO of the Association for Environment Conscious Building

violent storms expected to increase — wind uplift calculations may need to be rethought, and at the site level, roof slate and tile nailing practices currently adopted in more exposed locations, such as double nailing of each slate, should become standard.

Is the culture of construction ready for climate change?

No, is the short answer. As Andy Simmonds, architect and CEO of the Association for Environment Conscious Building (AECB), puts it: "Our industry needs to undergo a deep cultural transformation based on values more aligned to planetary health[3]."

Simmonds also believes we need to start thinking about what building materials will be available in a climate-changed word. "What will material supply chains be like? We need to start exploring opportunities to create genuinely circular economies for building components and materials, so our industry creates close-to-zero waste."

"For example, should buildings – or at least parts of them — be completely demountable, so all of their components can be taken apart and reused or reconfigured?"

Perhaps one way this approach can be put into practice right now is during repairs of flood-damaged building. Currently, this tends not to make the building any more resilient to flooding than it was previously. Urban design consultancy URBED looked into the way flood repairs were carried out in Cumbria after the devastating floods of 2015, and found damaged buildings were being re-instated 'as was', even though this was the second flood in 10 years for some properties.

URBED recommends that flood repair makes a building more resilient to future flood events, to reduce the need to strip out materials (reducing waste), and reduce drying times. Some of their recommendations are very simple – such as fitting plasterboard horizontally across a wall so less needs to be removed when only the bottom foot or so of a wall is damaged, or using water-resistant materials such as magnesium oxide boards instead.

Why we should build dumb boxes

All the above is assuming we can go on building, occupying and maintaining buildings more or less the way we do now. Is this likely? If the more extreme predictions for climate change come true – for example if the AMOC completely shuts down – or we fail to cut emissions, what kind of society and economy will be the setting for these buildings? Can we envisage a way in which our buildings will still work well, even with intermittent power and water, intermittent money, and much less "stuff" generally?

Geometry is a very basic key to resilience. A building with a poor form factor will get colder in an arctic blast – and in a power cut. An over-glazed building will overheat the most in a heat wave – and if it requires intensive cooling to prevent overheating, it will be a hell-hole in a power cut.

It already makes sense to design and build simple, compact buildings – "dumb boxes" in the parlance of some passive house designers, such as Seattle-based Mike Eliason. "Dumb boxes that are under six stories can be manageable in long periods without power, whereas tall skyscrapers are problematic under the same conditions," he told the green design blog Treehugger.com[4]. "And a neighbourhood of dense, dumb boxes only increases that resilience."

He continued: "'Dumb boxes' are the least expensive, the least carbon intensive, the most resilient, and have some of the lowest operational costs compared to a more varied and intensive massing," Eliason says. "Every time a building has to turn a corner, costs are added. New details are required, more flashing, more materials, more complicated roofing. Each move has a corresponding cost associated with it."

Not only that, but complicated shapes also make it harder to protect facades with generous overhangs. Echoing Andrew Yates, Eliason warns: "Every corner or recess or other façade modulation [increases] the chances of issues related to weathering, durability, and building movement."

Andy Simmonds believes that we now need new or adapted building standards that measure and verify not just carbon emissions or energy efficiency, but also climate-adaptability. "These need not be complex or onerous," he says. "And thermally comfortable, beautiful buildings with great indoor air quality need not be ostentatious."

Buildings and built environment professionals alike would do well to embrace modesty, simplicity and flexibility, he says. "We can't become wedded to certain ways of doing things, but need be able to move swiftly as the evidence for what works and what doesn't, and as the world around us, changes," he says. "Given how volatile our changing climate is, we are going to need our industry to be much more flexible and capable of responding to changing needs, changing supply chains, and a changing environment."

Image: Architype

How Exeter is building for the future

Exeter City Council, pioneers of building to the passive house standard, also require their buildings to be resilient and comfortable in projected climatic conditions for 2030, 2050 and 2080.

St Loye's Extra Care Scheme is a new £9.8m passive house development in the city that will provide independent living for older persons. Designed by Architype, the scheme will feature 53 affordable apartments plus lounges, dining rooms, roof terraces, hobby spaces, spa treatment rooms and landscaped gardens.

To ensure the apartments will remain comfortable long into the future, engineering consultancy e3 carried out modelling of the proposed design under future climate change scenarios using the EIS software.

This modelling showed that while the natural purge ventilation would be expected to keep the apartments comfortable under current conditions, there would likely come a point where a small amount of cooling would probably be needed to protect the vulnerable elderly residents.

The solution chosen by the team was to install a centralised ventilation system (which also made sense for other reasons) so that a cooling coil could easily be retrofitted to the supply air duct serving the building in future. The analysis predicts that from 2050 onwards the building will remain comfortable if the supply air temperature to each flat is cooled by 10C.

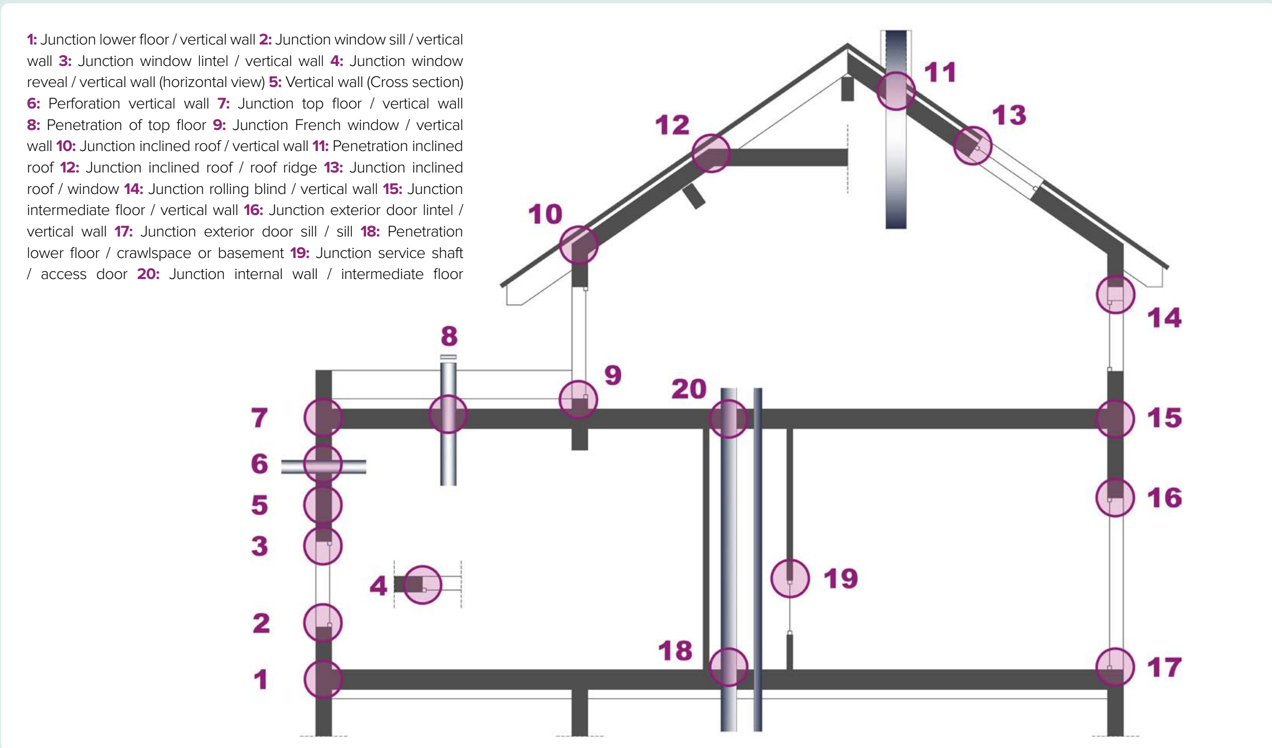
Because the apartments are passive house, the cooling load is expected to be very small – but it should make all the difference to the comfort of residents.

1. https://www.theguardian.com/society/2018/aug/03/deaths-rose-650-above-average-during-uk-heat-wave-with-older-people-most-at-risk **2.** see for example research reported by Dr Clive Shrubsole and by the US National Institute of Standards and Technology, relating to formaldehyde and off-gassing from spray foam insulation respectively **3.** www.aecb.net/sufficiency- efficiency-sustainability/ **4** www.treehugger.com/green-architecture/praise-dumb-box.html

PH+ guide to AIRTIGHTNESS

Once poorly understood by the mainstream building industry, airtightness is now increasingly seen as one of the most crucial objectives on any building project. Not only is it vital for energy efficiency, it's also key for thermal comfort and for protecting a building's structure from dampness and mould. In this comprehensive guide to airtightness, we look at why it's so important, how exactly it's measured, and most importantly, how to achieve it on site.

Words: John Cradden



(above) Diagram showing some of the potential main junctions and penetrations in a building envelope, where good airtightness detailing and workmanship will be required.

Even if you're a new reader of this magazine, it probably won't surprise you to know that airtightness is one of the fundamental building blocks – if you'll pardon the pun – of passive house design and construction.

It's also a critical component in any type of low or zero energy building project, including those that aim to meet the nZEB (near Zero Energy Building) standard for dwellings that will come into force in Europe after 2020.

But what is the benefit of making a home airtight, exactly? If designed right, airtight homes are warm, comfortable homes that are free from both draughts and condensation, and future-proofed against the extreme weather events promised by climate change.

As Simon McGuinness notes in his seminal article on the subject, "Airtightness - the sleeping giant of energy efficiency" (see Issue 7 of PH+), a building's airtightness is an indicator not just of its energy efficiency but its build quality. With a little care in design and on site, airtightness targets that might seem impossibly tough can be surprisingly straightforward to achieve.

That said, there are a few lingering misconceptions about the area, so educating and upskilling the building trade is hugely important not just for understanding what airtightness is all about, but appreciating just how much making a building properly airtight adds to its overall quality as well as energy-efficiency.

1 What is airtightness?

Airtightness is about eliminating all unintended gaps and cracks, holes, splits and tears where air can move into and out of the ‘conditioned’ space (heated or cooled space) of the building. Such gaps, cracks etc can account for up to 50pc of all heat losses through the external envelope of a building, and can be caused by poor build design, poor workmanship or the use of wrong or inappropriate materials. It is important to remember that an airtight building does not mean it is hermetically sealed, rather it means that unintended air leakage has been reduced to a minimum. (See point 4)

2 Why airtightness is so important in construction

Airtightness is important for avoiding heat loss as it means less uncontrolled air movement in and out of the building. Less heat loss also means your heating system will work more efficiently, thereby reducing heating bills and energy wastage. It also contributes to maintaining thermal comfort (ie. insulating better in winter and reducing overheating in the summer).

It can improve health by preventing substances that can provoke allergies being carried into the building via air leakage, and can also result in better sound insulation within the home.

Building durability is also enhanced through airtightness by preventing damage caused by moisture-laden cold air leaking into the building envelope and condensing.

In conjunction with a properly designed ventilation system, airtightness will eliminate damp and mould growth in the building fabric and vastly improve indoor air quality.

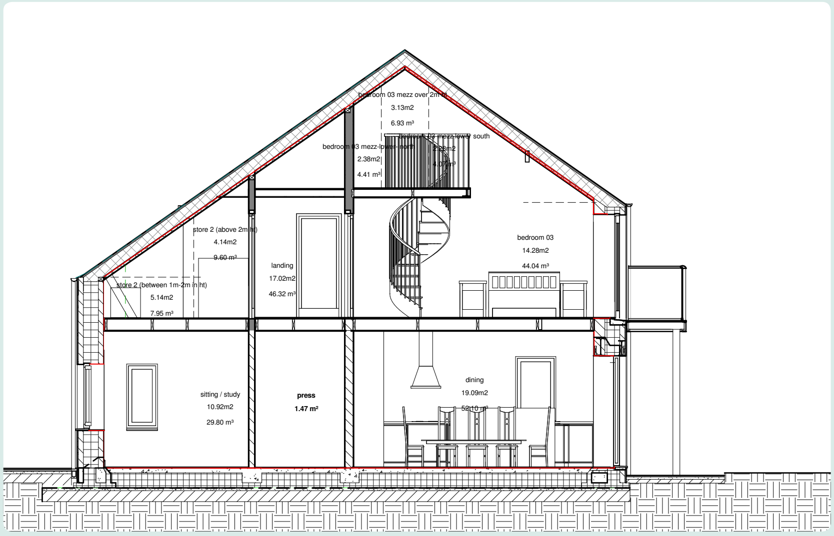
And last but not least, achieving good airtightness necessitates a higher focus on build quality and quality workmanship, which in turn should mean fewer call backs.

3 The rise of airtightness standards

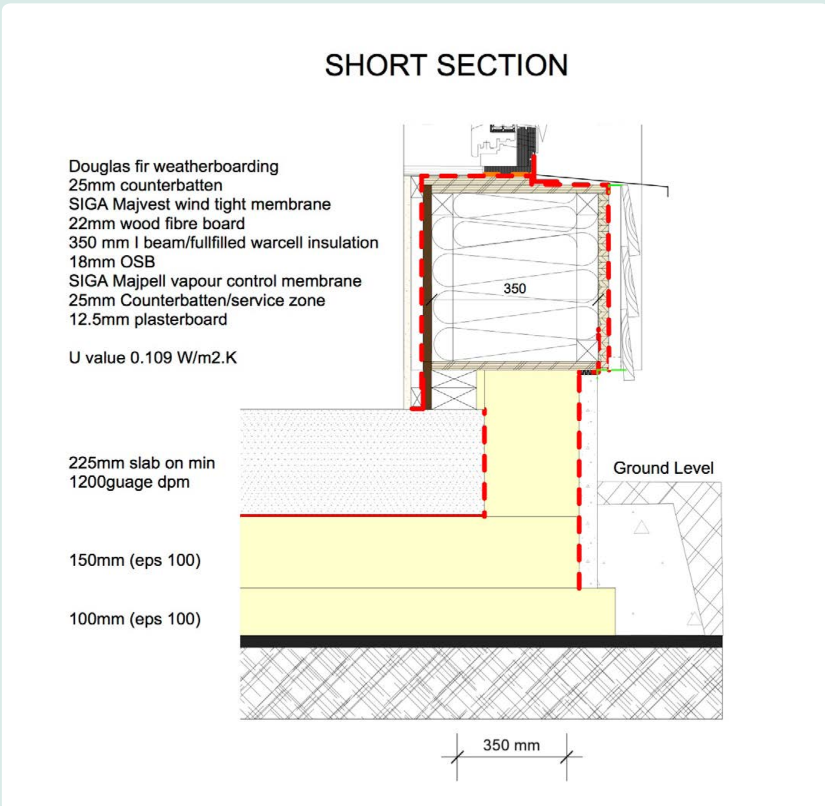
As awareness of airtightness metrics has increased, the average performance of new homes in Ireland has risen sharply.

The unpublished 2005 Energy Performance Survey of Irish Housing found that new homes built around the turn of the millenium had an average airtightness of 11.8 $m^3/hr/m^2$ @ 50 Pascals. By comparison, data from the National BER Research Tool shows the average airtightness for homes built in 2017 is 3.66 $m^3/hr/m^2$ – a figure that drops to less than 3 when the 18.5% of homes which used a default of 7 in lieu of testing are excluded).

But while scores in Ireland have improved dramatically since the last building boom, there are risks that averages may start to decline as activity resumes. With a skills shortage and the rush to build quickly, this is perhaps inevitable



(above) Example of a simple clear section drawing of a house with the airtightness layer marked clearly in red.



(above) Another easy-to-understand drawing, this time of a wall-to-floor junction, with the airtight and wind-tight layers marked clearly in red.

1 Airtightness membrane at the underside of a ceiling with taping around web-joists and other junctions; **2** airtightness taping around joist ends; **3** taping of membrane overlaps to underside of ceiling, with service cavity beneath; **4** specialised seals around penetration for wires; **5** and ductwork; **6** airtight membranes installed by Clioma House prior to the installation of internal studwork in a Long Life Structures build.

without particular care. A definite issue to watch.

In the UK, Air Tightness Testing and Measurement Association (ATTMA) data from 2017 suggests that the average airtightness for homes is around 5 $m^3/hr/m^2$.

While the passive house standard uses a different metric to measure airtightness – and more on that below – in a typical dwelling shape, a passive house would be hitting well below 1 $m^3/hr/m^2$.

4 Airtightness and ventilation

As mentioned earlier, a common misconception about airtightness is that it means letting no air into a building. Ventilation is crucial, as it is in any building – sufficient ventilation to remove pollutants, but not to the extent that occupants become uncomfortable and sabotage the ventilation source. Therein lies the problem for buildings that rely on leakage and/or natural ventilation: the ventilation rate may go from too little to far too much, depending on factors beyond the building designer's or occupant's control. But although many of us put up with patchy air quality in leaky buildings, this isn't an option in tighter buildings. Which invariably means installing some version of a mechanical and controlled system.

There is still a school of thought that believes that it is dangerous to make a building too airtight, or that the 'natural' ventilation generated by a leakier construction or enough holes-in-the-wall will be enough to offset the need for any kind of mechanical ventilation, (and by extension, the need to meet more stringent airtightness standards).

But any airtightness expert will knock big holes in this argument. "Number one, leakage doesn't give you ventilation," says Niall Crossan of Ecological Building Systems. "Number two, the holes in the walls during the coldest winter, on windy days it's just breathing, whereas on a still, calm cold day, it's not really giving you any air circulation, not adequate anyway. So the hole in the wall is really not an effective ventilation strategy at all."

Furthermore, it's argued that accidental infiltration via leaks in the building envelope can't be regarded as proper, fresh ventilation as aside from being intermittent, the air may have moved through unsanitary pathways.

But as we continue to make buildings more and more airtight, the use of controlled ventilation will become more critical – with 'control' being the key word. If a building envelope is not airtight, the ventilation is ultimately less reliable as it is not possible to control air movement in and out of the building.

And note another common misconception: a building can be both airtight and breathable. Breathability, in this case, is about ensuring that the building is vapour permeable (allows the movement of water vapour through the construction).

5 Airtightness testing & measurement.

The most common airtightness test is the 'blower door test', and which is now a building regulation requirement for new homes.

During any test, windows, flues, chimneys and vents are closed during the test. A fan is placed in a door or window and air is sucked out (de-pressurised) and blown back into the building (pressurised). During both these periods, the fan operator notes the amount of airflow. The airflow result is the average airflow during pressurisation and de-pressurisation, i.e. the amount of cubic meters of air per hour leaving / entering the home via gaps and cracks etc. The airflow per hour is then divided by the size of the building to give us the relative air-leakiness of the building.

Airtightness can be expressed in different ways, such as the n50 value used by the Passive House Institute (ACH @ 50Pa), and the q50 ($m^3/hr/m^2$) used for building regs and energy ratings in both Ireland and the UK.

The n50 value measures the number of times the entire volume of air in a building changes within an hour, while q50 measures the number of cubic meters of air leakage per hour per sqm of envelope area.

Both values assume a pressure differential of 50 Pascals (ie pressuring and depressuring to 50 pascals and averaging the results out). This is said to be equivalent to a 20mph or 30kmh wind hitting the home at the same time from all sides. In other words, a very windy day.

While the n50 value is not used in Irish or UK building regulations, many people use this measure when talking about airtightness. "It has the advantage that it is based on a volume divided by a volume, so the unit is very simple, and whether it's litres per second, cubic metres per hour or cubic feet per minute that is used, the air change rate type number stays the same," explains airtightness tester & consultant Gavin O'Se of Greenbuild.

The q50 and n50 results are often very similar in typical houses, a coincidence due to their geometry, and which also partly explains why some people – in error – use the two values interchangeably. The results can be wildly different in more unusual building forms and in larger buildings because, as the building gets smaller (say a tiny apartment) or much larger

(say a large supermarket), the ratio between internal volume and shell surface area changes a lot. This may also explain why it tends to be easier to achieve low n50 scores in larger buildings.

While pretty much all European countries use the same standard, there are variations between the units used so airtightness results are not always comparable across countries, according to O'Se. "For example in France they like to give their results at 4Pa not 50Pa, and in Denmark they like to use airflow per second rather than per hour – and divide it into the floor size rather than the shell, for good measure. In the USA, they like to use CFM – cubic feet per minute."

To underline how even the most stringent airtightness standards are highly achievable, Simon McGuinness notes that the current record airtightness for a house is 0.07 ACH – almost ten times better than the Passive House standard and more than 100 times better than the current (2011) Irish building regulations maximum. "So it's not rocket science."

6 Building regulations

In Ireland, proposed changes to Part L building regulations for new homes – set to come in next year to bring Ireland in line with the EU's nZEB requirements – means 5 $m^3/hr/m^2$ will be the new backstop air permeability for homes, down from the current level of 7 $m^3/hr/m^2$. Arguably the new target doesn't go far enough: as mentioned above, if we exclude homes where developers relied on type testing and inputted a default of 7 $m^3/hr/m^2$ for untested homes, new homes have averaged under 3 $m^3/hr/m^2$ every year since 2015. This is in part down to how the Irish building regs work: a number of (arguably unambitious) minimum compliance backstops are set for the likes of insulation and airtightness levels, but the building must achieve an overall 60% energy reduction compared to the 2005 regs. That means going beyond the backstops in several areas. Good airtightness is one of the lowest cost means of getting towards that target.

However, the proposed rules also say that while homes which score below 3 $m^3/hr/m^2$ must use mechanical ventilation, it's proposed that homes which score between 3 and 5 may still use natural ventilation – albeit with such a large area of background ventilators that the resultants homes may resemble swiss cheese. (Editor – an independent ventilation report seen by Passive House Plus on a typical Irish semi-d built to current Part L and suffering from mould found that the home should have had 22 background ventilators rather than the nine provided, in order to comply with current Part F requirements for homes below an air permeability of 5).

As noted above, under the current Part L 2011 rules, spot testing is permitted whereby, for example, a developer can test a (low) percentage of each house type in a housing scheme and extrapolate for the rest. Under the proposed new regulations, it's proposed that all new homes should be tested.

According to O'Se, the spot testing rules allow developers to enter the worst case of 7 $m^3/hr/m^2$ to be entered into the BER for units that are not tested, even though these units may be worse than this in reality. In 2017, 18.5% of new homes used this default.

For non-domestic buildings, the new Part L regulations will require a q50 of 5.0, along with a requirement for testing. The previous target was 10.0, but with no requirement for testing.

10.0 is still the backstop for new homes in England, Wales, Scotland and Northern Ireland, but data from the ATTMA (Air Tightness Testing and Measurement Association) shows industry is achieving less than 5 on average.

In the UK, there have been concerns expressed about the quality of data on airtightness tests and that many builders are gaming the testing procedure. A study of the airtightness test results from over 100,000 new homes by the Air Tightness Testing and Measurement Association (ATTMA) with the University College London Energy Institute found evidence that homes are not being built airtight enough but are undergoing short term sealing measures to enable them to pass the test.

1 Paul Jennings conducting a blower door test to check a building's airtightness; **2** builder Mike Whitfield using a smoke pencil to look for air leaks; **3** sealing of a ventilation duct prior to a building's airtightness test.

7 Making a building airtight

Airtightness experts all speak of the crucial importance of designing in the airtight layer early on. As passive house consultant Nick Grant of Elemental Solutions puts it, airtightness is "90pc design, 10pc extra effort by the contractor".

"A designer can't just write airtightness target into contract. They have to make it easily achievable – that is a design responsibility," he said. "Many mistakes are already made by planning. Internal garages, changes from 1 to 2 storey etc all create airtightness challenges that need a neat solution or lots of time on site and then a poor result. With experience, a designer will spot the challenges and either design them out or be prepared to help the contractor solve the problem before construction starts."

It's also critical to make it very clear to everyone on site where the airtightness layer is. "Hundreds of carefully drawn details are not as good as a page of A3 with simple key details," he said.

Designers should get their hands dirty and "go to as many blower door tests as they can and should do some airtightness sealing to get a feel for what is involved. Ask contractors and subbies for ideas, ask what is difficult and what would be easier next time. Designing a detail in 2D in a warm office is not the same as trying to sort where three such details happen to join on a wet afternoon."

Niall Crossan advocates the specific approach of designing junctions to be as simple as possible in order to reduce the amount of work involved in building airtightness, and, by extension, the cost. As a guide, he says "the ▶

more intricate the junction, the more detailed analysis is needed, the more material you need, the more man-hours you need. It ends up costing more and you end up with a worse result. Whereas if you can simplify junction details you need less man hours and less material, which isn't very good for our business but then you end up with better results and less cost."

But even as awareness and knowledge of airtightness becomes more widespread and mainsteam throughout the trade, site control will still be vital, "because airtightness isn't aligned to one trade; airtightness involves any person who interacts with your external envelope", says Crosson. This means ensuring that as many of them as practically possible should get trained or arrange for workshops on site.

Fintan Smyth, building physics manager with Gyproc & Isover Ireland, highlights the work the company has been doing to upskill the market at its technical academy, training everyone from designers, to tradespeople, to builders merchants staff on airtightness. Smyth reckons circa 4.000 have had airtightness training – with about 1.500 having detailed training on full day courses specific to airtightness.

"Our academy trains between 1.200 and 1.300 people per year on three full day courses, with a course portfolio including nZEB in practice, airtightness and advanced airtightness – all practical courses." Smyth said the company's nZEB course – which focuses on building fabric – is derived from the Passive House Institute's certified passive house tradesperson course.

The idea of appointing an airtightness champion on sites (particularly on bigger sites), is becoming more popular. "Good airtightness requires an on-site airtightness champion – and it must not be the site manager," says Paul Jennings, an air leakage specialist with Aldas. "It can be the client – OCD self-builders tend to deliver very airtight dwellings – or a deputy site manager. They need to know the job intimately, and have the authority to tell the electrician or plumber they see making a hole in the wrong place to stop – and make it stick."

Planning the sequencing of all the relevant steps in the airtightness process is important, too from inspections, recording (including photographing) sealing works, number of airtightness tests and when they need to happen.

8. Primary airtightness products & systems

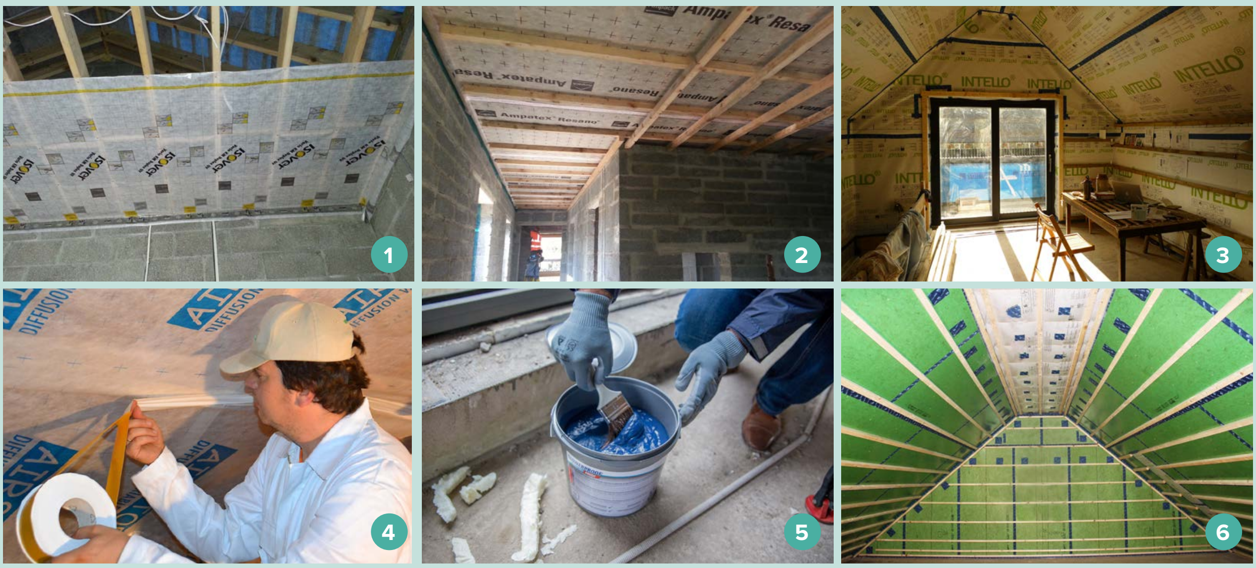
When it comes to choosing specific products, the bottom line is that whatever is used must be fit for purpose and last for the lifetime of the building, especially since there will be little or no access to the airtight layer after a building is complete.

Airtightness tape is typically used for covering junctions and penetrations, but unlike other products such as membranes, there are no harmonised EN standards for tape – though one is under development. According to Crosson, it's expected that a new Din standard being developed in Germany – which assesses the durability of airtightness tape – will become an EN standard. Some manufacturers are already testing to this standard. For example, Pro Clima's primary tapes has been reportedly tested to an expected life of 100 years, although this proposed standard is proposing that any tape must pass 17 years to be considered 'permanent'.

There is a large disparity in the quality of tapes and sealants on the market that has been shown in various aging tests, but the best tapes and sealants typically use solid acrylic technology, said Crosson.

A number of airtightness systems are currently certified by organisations such as the BBA (British Board of Agrément) and NSAI Agrément and PHI. And while there are many tried and tested products, there are always plenty of innovations to keep up to date with.

Two of the most notable include Smartply ProPassiv, a Passive House Institute certified airtight OSB panel with an integrated vapour control layer that many like because it is very robust and can be used as part of the structure; and liquid membranes that you paint on from



Some popular airtightness membranes include **1** Isover Vario **2** Ampatex **3** pro clima Intello and **4** Airstop Diva Forte. Newer airtightness product innovations on the market include **5** Blowerpoof liquid airtight paint and **6** Smartply ProPassiv airtight OSB.

1 Applying airtightness tapes prior to window installation; **2** airtightness quality control station on a Shoalwater Timber Frame passive house build for Michael Bennett Group; **3** airtightness membrane and taping around window junctions.

the likes of Blowerproof, Soudal, Isocell and Pro Clima.

In a masonry build, wet plaster for masonry (or polished concrete/screed for floors) is a reliable way to build an airtight layer, but you need to plaster all areas, even if they're not exposed.

"Choose the right products, and use them properly," says Jennings. "If inexperienced, get trained – the best suppliers of airtightness products offer 1-day courses and will often visit your site to ensure you are using tapes and other products properly."

9 Which build system is most airtight?

Although with careful design detailing and workmanship it's possible to make any build method airtight, certain approaches have inherent advantages. Insulating concrete formwork systems tend to achieve an airtight wall without much effort due to the continuous nature of the poured concrete core. Similarly structural insulated panels tend to score well due to the continuity of the insulated core and the relatively airtight nature of OSB, provided care is taken to tape panels together.

Wet plaster can make masonry walls tight too, provided both exposed and hidden wall sections are covered, though extra care is required with tricky penetrations like joist ends and wall chases. Dry lined masonry walls can be made tight too by battening out and installing a membrane, or with a parge coat on the masonry. Proprietary products like Gyproc Airtite Quiet plaster are marketed for this use.

Timber and steel frame do not have inherent airtightness advantages, but the best suppliers are capable of exceptional results. The best scores Passive House Plus has ever reported tend to come from master timber framers – the likes of Shoalwater Timber Frame, Clioma House and Touchwood Homes have achieved results of less than 0.1 ACH, while the likes of Cygnum, MBC Timber Frame, Beattie Passive & Eco Timber Frame have developed track records of reliably beating the passive house target of 0.6.

With timber and steel frame walls, a membrane is a must – either in sheet or board form. In the case of timber frame, where it's important to minimise risk of interstitial condensation, the membrane doubles as a vapour control layer. In the Irish and UK climate, this should be on the warm side of the main insulation layer, to prevent risk of vapour condensing between insulation and airtight layer. There are external airtight layers on the market which offer the promise of a simple, continuous airtight layer protected from service penetrations, but there are concerns that such approaches are inherently risky in the absence of a reliable means of preventing vapour from entering the insulation layer and condensing.

10 Retrofit:

It's generally regarded that much less ambitious airtightness targets should be set for existing buildings, given the limitations posed by existing junctions and the need to gut a building to make meaningful improvements. But this is a case where external airtight layers on solid block walls – air movement in hollow blocks or in cavities may limit its application otherwise – may actually prove transformative, such as liquid membranes applied to the outer face of walls before external insulation layers are applied. There would have to be consultation between the external insulation supplier and paint supplier to ensure there's no compromise on the integrity of the system.

And if external insulation isn't an option, there are alternatives. For instance, Isover's NSAI Agrément certified Optima dry lining system combines an insulated steel frame, behind a taped airtightness membrane and plasterboard to finish.

That said, it's a misconception that existing building stock are always leaky. Not the case. The fabric of older homes can be remarkably airtight, such as those built with mass concrete and wet plastered walls. An Energy Action study found six Dublin homes built between 1920 & 1940 averaged below 5 $m^3/hr/m^2$ whereas the remaining 14 homes in the study built between 1960 & 1980 average 9 – with the worst three all being the newest.)

If the prospect of making an old building airtight deflates you, it's worth noting that Michael Nally & Sons of Galway produced a retrofit with a leakage rate of just 0.37 ACH on a Simon McGuinness-designed passive house retrofit. What's more the contractors were novices to airtightness. So that's not rocket science, either.

Next issue...

The PH+ guide to:

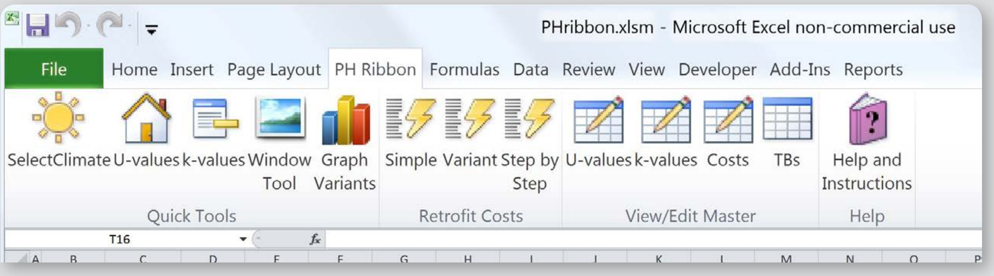
timber frame

Which is better - stick built or pre-engineered? Open or closed panel? And how do you ensure they're well insulated, fire-proofed, low impact, regs compliant and built to last - without costing a bomb?

Find out all this and more in the next issue.

AECB launches new toolbar to make PHPP faster & easier

The AECB has launched PHribbon, a new software addition to PHPP (the Passive House Planning Package). At the association's annual conference in Garway, Herefordshire in September, the software's author Tim Martel gave a workshop demonstrating its use for new build and retrofit. PHribbon is designed to greatly speed up and add extra functions. Parts of PHribbon have been available in an earlier form since January 2017.



"Every passive house designer knows that PHPP greatly improves on the accuracy of SAP and removes the large performance gap often found using SAP where buildings do not generally meet their designed performance," Martel said. "PHPP is designed to account for the complexities of energy in use, though up until now models have taken longer to construct."

"However, PHribbon changes that. PHribbon can cut the time to create a PHPP by around a third while improving accuracy and greatly reducing human error," he said. PHribbon works directly in PHPP but is separate from it, and operates from a toolbar (actually a ribbon) like any other in Excel.

There are two main versions of PHribbon, one for new build and one for retrofit. The retrofit version has the full toolbar pictured, whereas the new build version has the first five buttons on the left, plus the 'U-values' and 'K-values' buttons towards the right.

Both versions have libraries of U-values and K-values including links to BBA certificates, a climate tool that shows counties within each climate region, a window tool that makes complex windows easy to enter, and a graphing tool to show where improvements are required.

In the retrofit version three more tools are added to give indicative costing. This version can compare costs of various retrofit options, handle incremental retrofits, and it has a library of 71 typical Psi values for thermal bridges. Libraries are editable and the user can easily add new entries. There are two further international versions of PHribbon available without the UK climate map.

"Affordability was a main concern, and therefore the software sells for £45 for the new build version, or £75 for the version including retrofit costing," Martel said.

Further information is available at **https://www.aecb.net/aecb-phribbon/** ■

Marketplace News

(above) The new Brink Flair 325 MVHR system, supplied by CVC Direct, has a unique method for providing accurate control of airflow.

Precise air control crucial for MVHR performance — CVC Direct

An important consideration when choosing an MVHR system is deciding between constant speed fans and constant volume fans, according to leading MVHR supplier CVC Direct.

Nicholas Vaisey, the company's business development manager, explained that constant speed fans will run at a predefined speed and do not adjust according to system pressure. The air flow rate will reduce as the system pressure increases. However, the system will use a constant amount of electrical power.

Constant volume fans, by contrast, will maintain the commissioned airflow regardless of the system pressure (within limits). The fan speeds are automatically adjusted according to the system pressure. When there is a noticeable variation in airflow, caused by resistance in the system, the speed of the motor(s) is adjusted to maintain a constant volume of air.

The new Brink Flair 325 MVHR system, supplied by CVC Direct, has a new unique method for providing accurate control of airflow, Vaisey explained. This is achieved using an anemometer fitted to the discharge tube of each fan, enabling a fast and very precise response to airflow requirements.

"The use of constant volume fans helps ensure the desired performance levels remain consistent over time," Vaisey said. "This feature simplifies the procedure and ensures that the supply air and extract air rates are exactly balanced.

"Many factors can affect the system pressure, such as blocked filters, change in wind pressure, blocked external vents and increased resistance in the ductwork."

He explained that when an MVHR system is running at an imbalance due to one of the factors above, it will result in a positive or negative pressure in the dwelling. This will cause inefficiencies as some of the air will pass through the leaks in the building fabric rather than via the heat exchanger.

"Having a balanced system not only reduces heat losses but will also prevent structural damage – especially in older buildings. There is a possibility that warmer, humid, indoor air can penetrate the structure of a building and, on reaching a colder external surface, can cause condensation leading to damage." ■

(right) Charlie Luxton, who will speak at the first event in Ecological's Perfect Airtight Seal tour on 16 October in Swindon, while the London event on 18 October will take place in the Building Centre (pictured).

Charlie Luxton launches Ecological's UK seminar tour

Sustainable building products specialists Ecological Building Systems have secured sustainable design expert and TV presenter Charlie Luxton as the guest speaker for the Swindon event on Tuesday, 16 October that will kick off the company's forthcoming Perfect Airtight Seal seminar tour of the UK.

The presenter of More4 programmes Building the Dream, Homes by the Sea and Homes by the Med, Luxton is an active pioneer of sustainable architecture through his eight person practice, Charlie Luxton Design.

Taking place at the National Self Build and Renovation Centre, the Swindon seminar will kick-start the five-location tour, which will bring together architects, specifiers and construction professionals for a full day's programme of presentations, technical talks and practical demonstrations.

The theme of the tour is 'optimum energy efficiency, freedom from structural damage and improvements in healthy living'. All five events will bring together international expertise in the use of high-performance building products, building physics knowledge and innovative design to drive improved sustainability in the UK's built environment.

The seminars are worth six structured CPD points and are relevant to five of the 10 RIBA CPD Core Curriculum topics. The seminar tour has been instigated by Ecological Building Systems in partnership with airtightness specialist Pro Clima to celebrate BBA approval of the company's Intello Plus membrane, which is distributed exclusively in the UK by Ecological Building Systems.

Commenting on the forthcoming event, Charlie Luxton said: "There are lots of opportunities for architects to find out about new products and design methodologies but there are very few events that bring together such a wide range of experts to provide joined up insights into how more sustainable, comfortable and robust buildings can be designed and constructed in practice."

The Swindon event will be followed on 18 October with the second seminar in the Building Centre, London. Guest speakers at the London event will include Simon Corbey of the Alliance for Sustainable Building Products (ASBP) and Patrick Chester, project manager and passive house consultant with Enhabit.

Other speakers at all five events will include Jon Denyer, senior scientist on the BBA's technical excellence team and Michael Foerster, engineer head of applications technology at Pro Clima.

After Swindon, the programme will tour venues in London (18 October), Belfast (6 November), Glasgow (8 November) and Birmingham (22 November). For more information or to book for an event visit **www.IntelloSealOfApproval.com** ■

CFC scandal reveals need to consider building material life cycles — NBT

Leading sustainable building product supplier Natural Building Technologies (NBT) has called on the construction sector to thoroughly examine the whole life cycle of building materials following the revelation that the manufacture of plastic foam insulation in China had contributed to a surge in emissions of CFC-11, an illegal ozone-destroying chemical.

Earlier this year, the Environmental Investigation Agency revealed that 18 out of 21 factories it investigated in China confirmed using CFC-11 to produce foam insulation despite the chemical's illegality. In a blog post on the company's website, NBT managing director Andy Mitchell stressed that while it's unlikely those who purchased this insulation were aware of the CFCs used in its manufacture, the issue was that those who used it "did not check or question the reasons why it was so cheap; they simply selected it because the price was right and it ticked the box for thermal performance."

He continued: "It's a cautionary tale that's symptomatic of a widespread failing in the construction sector: rather than considering the environmental impact of building materials throughout their lifecycle on a cradle-to-cradle basis – raw material, manufacture, transportation, installation, service life, recyclability/re-use – many specifiers are simply focused on whether they deliver the performance to meet EPC, BREEAM or LEED requirements at the right cost."

Mitchell said that a combination of tight budgets, small profit margins and a specification culture that considers purchase price above all else means specifiers often look for the cheapest solution. He also pointed to the lack of legislation restricting the embodied carbon emissions of materials.

He continued: "There is a bitter irony in the fact that, by meeting thermal performance standards designed to improve environmental standards, those specifying the cut-price insulation have probably done more environmental damage than an uninsulated building would have during its lifetime."

NBT supplies the Pavatex range of wood fibre insulation boards.

"Until we begin to look at the environmental impact of the construction sector more holistically – from both a cultural and legislative point of view – we cannot achieve the goal of constructing buildings that manage both the financial and environmental project cost effectively." You can read the full blog post at **www.natural-building.co.uk/news** ■

Five of the six Which? 'Best Buy' boilers from Viessmann's condensing gas boiler range.

Viessmann gas boilers awarded Which? Best Buy status

Viessmann has secured a Which? Best Buy status for its six most popular Vitodens gas boilers (listed below) for the second year in succession. The annual survey by Which?, the UK's largest consumer organisation, conducts robust research in order to "reveal the boiler brands you can trust."

Viessmann is also one of only two boiler brands to score five stars for reliability, customer satisfaction, and engineers' recommendations. In the overall brand assessment – based on reliability, customers' scores, and the expert views of engineers – Viessmann's scored second place in the table. Which? reports that the survey again resulted in "a huge difference in overall score between the best boiler brands and the worst."

Which? conducted the survey in May 2018, questioning just fewer than 12,000 boiler owners and 166 heating engineers who are registered trusted traders. The report stated that Viessmann's boilers "have excellent build quality, are easy to repair and even non-incentivised heating engineers would recommend them."

Graham Russell, Viessmann managing director, commented: "We are delighted to receive this endorsement for the second year running. It is reassuring to hear from a respected independent source that our Which? Best Buy boilers are pleasing end-users. And it is especially satisfying to score a top rating from heating engineers.

"We believe this reflects the fact that many more installers are becoming familiar with Viessmann products and we hope more still will give us a try in the coming year."

The six Which? 'Best Buy' boilers from Viessmann are the Vitodens 050-W 29 kW, Vitodens 100-W Combi 30 kW, Vitodens 100-W Open vent 26 kW, Vitodens 111-W DHW Storage 35 kW, Vitodens 200-W System 35 kW, and Vitodens 200-W System 60 kW. ■

ICF robust against natural & man-made disasters — NUDURA

Insulating concrete formwork (ICF) offers significant advantages over other methods of building envelope construction when it comes to designing resilient and robust buildings that can withstand natural and man-made disasters, according to Jean-Marc Bouvier, director of sales and business development at leading ICF specialist NUDURA. The company is now offering a variety of training opportunities, including RIBA Core Curriculum CPD seminars, to help the industry to better understand its ICF system.

"When it comes to natural disasters, tornadoes often spring to mind. Surprisingly, based on our land mass, you are more likely to see a tornado in the UK or the Netherlands than anywhere on the planet. However, most tornadoes that form in this country are generally weak in comparison to most," says Bouvier.

"The key challenge in Britain is to design and build structures which can resist threats brought on by both mother nature and those which are man-made. So, robustness against explosions, fire, flood, energy efficiency and sound attenuation are key."

Bouvier said that insulating concrete formwork offers proven resilience above and beyond other types of building envelope construction. The NUDURA system has been used in Canada to construct buildings of 25 storeys but is capable of being built to 40 storeys.

"In parallel to unlimited design capability for both complex and curved structures below and above ground, due to the solid monolithic nature of concrete, these inherent characteristics are a standard part of the package for superior safety and stability. To add such attributes to other construction methods just adds extraneous cost."

ICF uses polystyrene connected with a web system allowing the forms to be stacked and steel reinforced. The polystyrene forms are then built up on site and filled with ready-mixed concrete.

Bouvier explained how NUDURA ICF offers resilience and robustness against natural and man-made risks.

Fire & flood

Bouvier said NUDURA ICF offers four-hour fire protection. Tests show the NUDURA system is no more toxic than burning wood and does not pose any risk of exposure to hydrogen cyanide. Acrylic/silicone render can be used in flood-prone areas.

Energy efficiency and mould resistance

According to NUDURA, the combination of polystyrene with concrete provides significant thermal mass, allowing ICF structures to be heated and cooled more effectively, therefore avoiding interstitial condensation and thermal bridging. NUDURA's Psi values for linear thermal transmittance are as low as -0.094. Its temperature factor for humidity and mould is f=0.856 and 0.969, exceeding the regulatory minimum of 0.75.

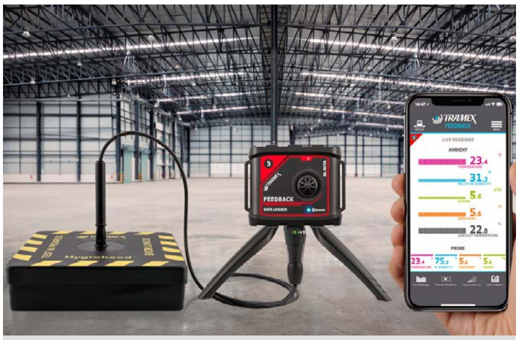
Sound reduction

In terms of sound attenuation, noise is becoming an increasing nuisance to building occupiers. NUDURA's sound reduction index measures 51 or better.

NUDURA ICF is available in the UK through an extensive authorised distributor network. You can learn much more about NUDURA ICF through a RIBA Core Curriculum CPD seminar, a DCE event, or at the company's training academy for an introductory one-day ICF training course.

For more see **www.nudura.co.uk** ■

(above): At a cost of C$40m, the ICF Builder award-winning Richmond Street apartment block in London, Ontario is one of the tallest projects ever specified in NUDRA ICF. It comprises 19 above-ground storeys and covers over 31,000 square metres of floor area.



Tramex launches two new data loggers for buildings

Tramex, the Irish designer and manufacturer of moisture monitors, has launched two new FeedBack DataLoggers — the DL-RHTA and DL-RHTX — for monitoring ambient conditions in buildings. Both systems monitor ambient temperature, relative humidity, dew point and grains per pound. The DL-RHTX unit, however, comes with an external probe which can also monitor in-situ conditions when testing concrete. Metering and logging data of this nature may prove critical to understanding the impact of energy efficiency interventions on building fabric and indoor air quality.

Each unit is capable of storing up to 100,000 data entry points and of running for 12 months on a single AA battery. The devices offer Bluetooth connectivity so that data can be viewed and downloaded from nearby iOS or Android devices.

The accompanying and free-to download Tramex FeedBack App is designed to be intuitive and easy-to-use, allowing the user to scan for available FeedBack DataLoggers within 50 metres, and displaying live temperature and humidity readings, as well as contact surface temperature if the CTP probe is connected. The app allows users to visualise thermal conditions and psychrometric charts as well as creating and exporting spreadsheets, charts and reports.

Founded in 1974, and working in partnership with researchers from Trinity College Dublin, Tramex invented, patented and developed the world's first non-destructive moisture meter for buildings, making it possible to detect and trace the source and extent of moisture problems without causing any damage to the material being tested.

For more information see **www.tramexmeters.com** ■

(above) Tramex's FeedBack DataLoggers include the DL-RHTX – which comes with an external probe – and DL-RHTA.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